

1037

OPERATOR'S INSTRUCTION BOOK



DIAL TYPE MILLING MACHINES



Publication No. M-1953-2

This Booklet should be Filed in the Tool
Crib and Issued by Tool Check only

THE CINCINNATI MILLING MACHINE CO.,
CINCINNATI 9, OHIO, U. S. A.

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MODEL

415-16 VERT-DT

THIS booklet was written for operators of CINCINNATI® Dial Type Milling Machines.

At the time of writing, the booklet was completely up to date. However, due to continual improvements in design, it is possible that descriptions contained herein may vary slightly from the machine delivered to you. This merely implies that the machine has been improved to better fulfill your requirements.

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**THE CINCINNATI MILLING MACHINE CO.
CINCINNATI 9, OHIO, U. S. A.**

ILLUSTRATION REFERENCE NUMBERS

For your convenience in quickly finding illustrations referred to in the text, we have given all illustrations the same number as the page on which they appear. For example, Figs. 30A and 30B, are both on page 30.



PATENT NOTICE

The machines and attachments illustrated and described in this book are manufactured under and protected by issued and pending United States and Foreign Patents.

The design and specification of these machines are subject to change without notice.



S E R I A L N U M B E R

The serial number of the machine is stamped on the face of the column and also on the right-hand end of the table.

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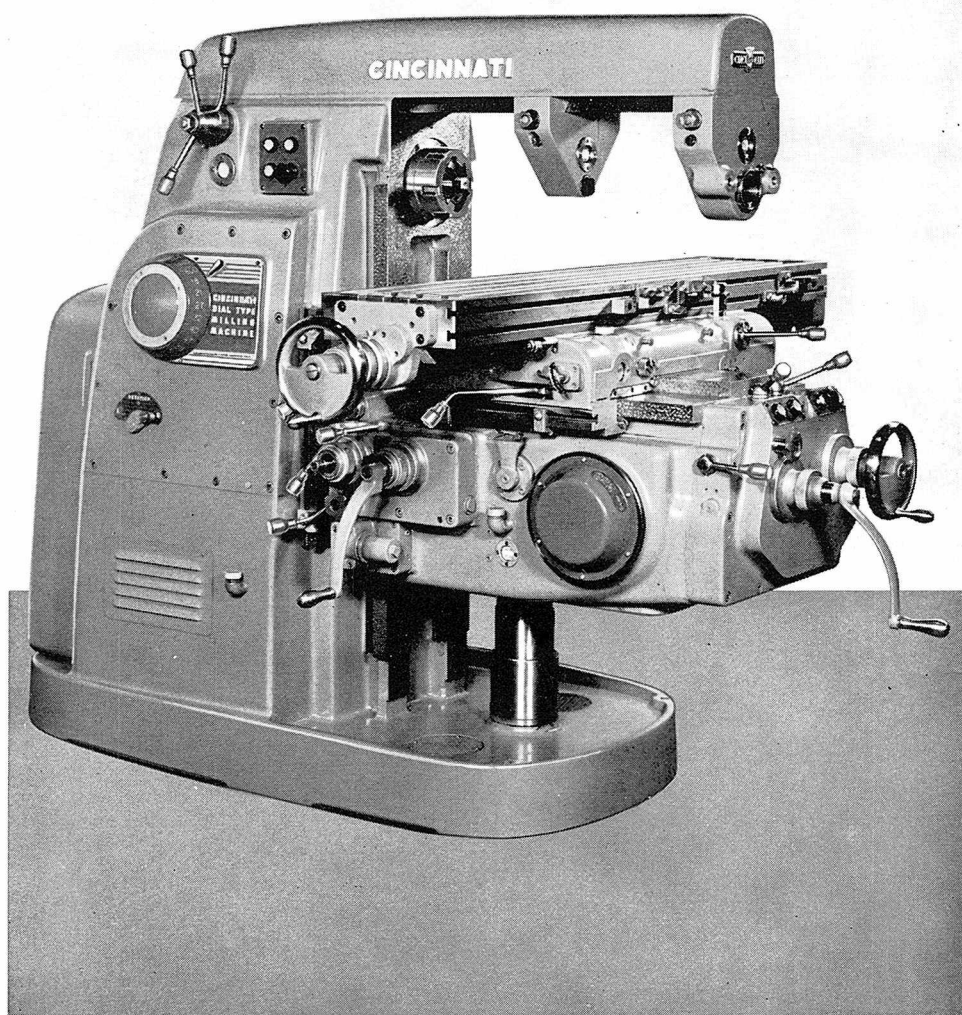


Figure 5A
Cincinnati Plain Dial Type Milling Machine

CINCINNATI DIAL TYPE MILLING MACHINES

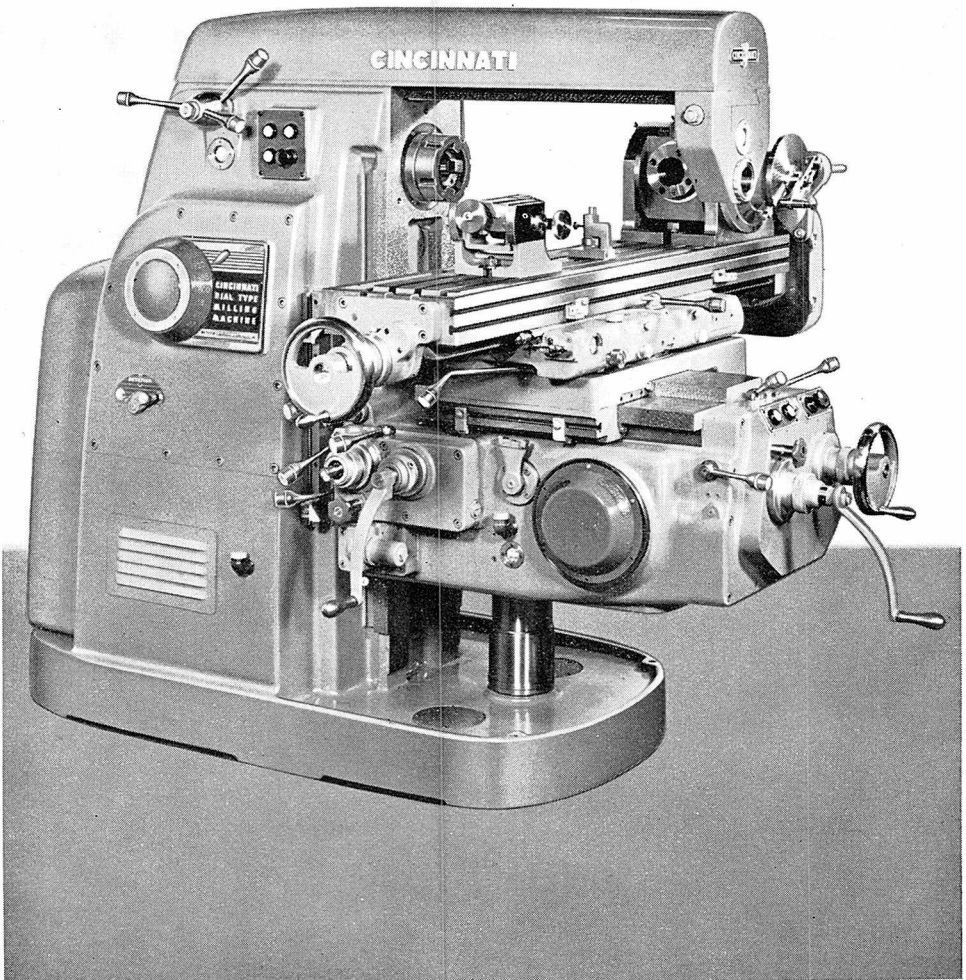


Figure 6A
Cincinnati Universal Dial Type Milling Machine

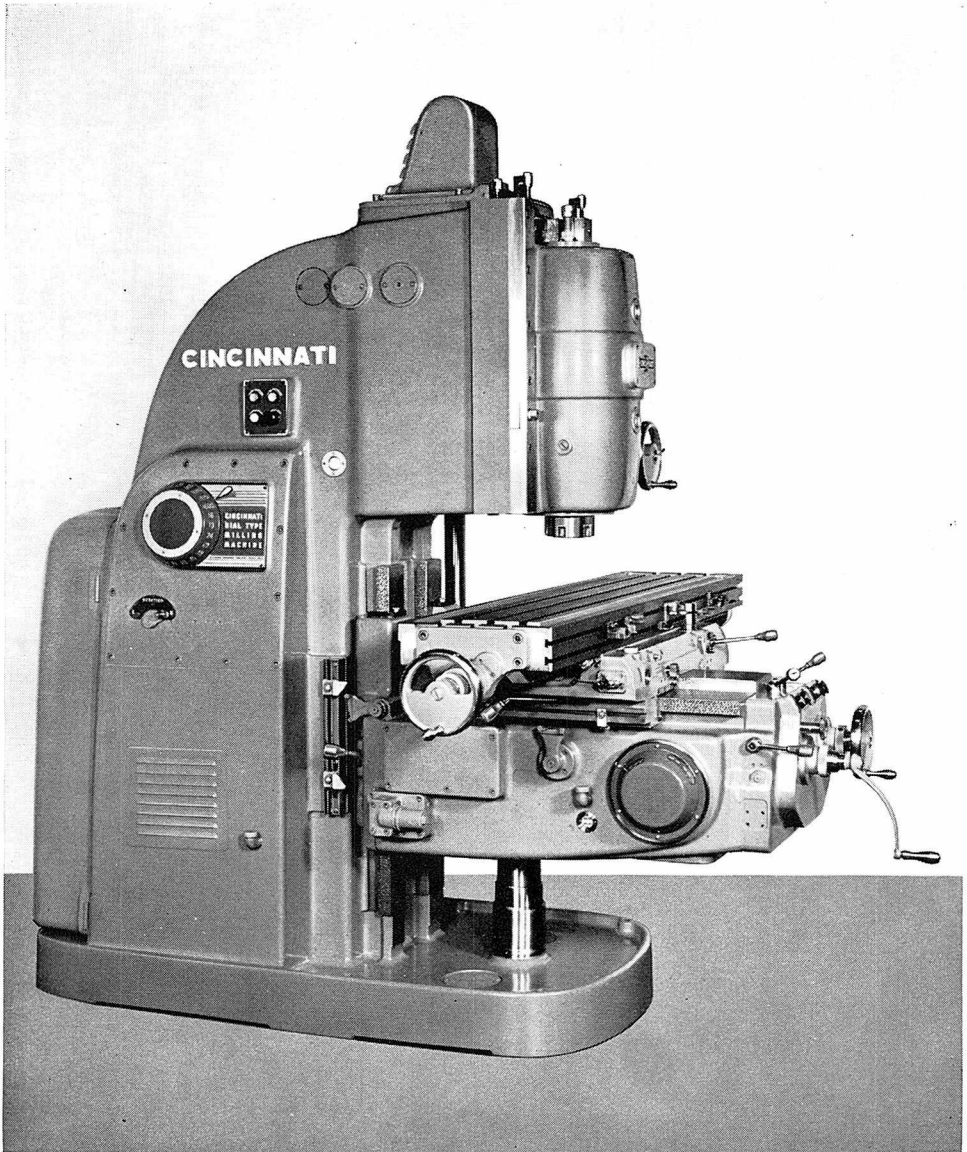
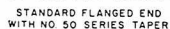


Figure 7A
Cincinnati Vertical Dial Type Milling Machine

DIMENSIONAL DRAWINGS



SIZE OF MACHINE	U		V	W	AA	CC	DD	EE	FF	GG	HH	JJ	KK	LL	MM	NN	PP	RR	SS	TT	UU	VV
	Min.	Max.																				
210-12	32%	51%	51%	66%	59%	2%	6%	6	12%	1%	3/4	3/8	1/4	23	23	52%	105%	104%	13%	28	17%	45
310-12	32%	51%	51%	66%	65%	2%	6%	6	12%	1%	3/4	3/8	1/4	25	21	58%	117%	104%	13%	34	17%	45
315-15	34%	54%	54%	71%	68%	3%	5%	7 1/2	15%	1%	3/8	1/2	1 1/2	28	21%	62	121	113%	16%	34	18%	54%
415-15	34%	54%	54%	71%	76%	3%	5%	7 1/2	15%	1%	3/8	1/2	1 1/2	30	19%	70	137	117%	16%	42	18%	54%
420-16	34%	54%	54%	71%	79%	3%	5%	8	16%	1%	3/8	1/2	1 1/2	31	23%	70	104%	117%	16%	42	18%	54%
520-16	34%	54%	54%	71%	87%	3%	5%	8	16%	1%	3/8	1/2	1 1/2	31	23%	78	156%	117%	16%	50	18%	54%

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MACHINE SPECIFICATIONS

GENERAL SPECIFICATIONS

SIZE and STYLE	210-12	310-12	315-15	415-15	420-16	520-16
TABLE						
Working surface	59¼"x12½"	65¼"x12½"	68½"x15¼"	76½"x15¼"	79¾"x16¼"	87¾"x16¼"
Size overall	59¼"x12½"	65¼"x12½"	68½"x15¼"	76½"x15¼"	79¾"x16¼"	87¾"x16¼"
T-slots, number and size	Three—1½"	Three—1½"	Three—1½"	Three—1½"	Three—1½"	Three—1½"
Distance between T-slots	2½"	2½"	3¼"	3¼"	3¼"	3¼"
RANGE						
Longitudinal	28"	34"	34"	42"	42"	50"
Cross	10"	12"	12"	14"	14"	16"
Vertical	19"	19"	20"	20"	20"	20"
Centerline spindle to top of table						
Max.	19"	19"	20"	20"	20"	20"
Min.	0"	0"	0"	0"	0"	0"
SPINDLE						
Spindle nose	No. 50 Std.	No. 50 Std.	No. 50 Std.	No. 50 Std.	No. 50 Std.	No. 50 Std.
Hole for draw-in bolt	1½"	1½"	1½"	1½"	1½"	1½"
Speeds { Number	24	24	24	24	24	24
Range { Range	18-1800 rpm	18-1800 rpm	16-1600 rpm	16-1600 rpm	16-1600 rpm	16-1600 rpm
No. 210-12 and 310-12 Machines—18, 21, 27, 32, 40, 47, 58, 70, 88, 105, 128, 153, 210, 251, 315, 377, 462, 552, 680, 812, 1020, 1220, 1485 and 1800 rpm.						
Nos. 315-15, 415-15, 420-16 and 520-16 Machines—16, 19, 24, 29, 35, 42, 52, 62, 78, 93, 114, 136, 188, 221, 280, 334, 410, 489, 605, 720, 906, 1080, 1325 and 1600 rpm.						
FEEDS						
Number of feeds	32	32	32	32	32	32
Range {	Longitudinal and cross	¾"-90"/min.	¾"-90"/min.	¾"-90"/min.	¾"-90"/min.	¾"-90"/min.
	22, 27, 31, 39, 45, 54, 63, 79 and 90".	¾, ¾, ¾, 1½, 1½, 1½, 1½, 1½, 1½, 2¼, 2½, 3¼, 3¼, 4½, 5¼, 6¼, 7½, 9, 11, 13, 15¼, 19,				
	Vertical	¾"-45"/min.	¾"-45"/min.	¾"-45"/min.	¾"-45"/min.	¾"-45"/min.
Vertical rates are ½ longitudinal rates.						
POWER RAPID TRAVERSE						
Longitudinal and cross	150"/min.	150"/min.	150"/min.	150"/min.	150"/min.	150"/min.
Vertical	75"/min.	75"/min.	75"/min.	75"/min.	75"/min.	75"/min.
OVERARM (Dynapoise)						
Underside to centerline of spindle	6½"	6½"	7¾"	7¾"	7¾"	7¾"
DRIVE						
Spindle drive motor	10 hp	10 hp	15 hp	15 hp	20 hp	20 hp
Feed drive motor	3 hp	3 hp	3 hp	3 hp	3 hp	3 hp
FLOOR SPACE						
Maximum size	105¾"x104¾"	117¾"x104¾"	121"x113¼"	137"x113¼"	145¼"x117½"	156¼"x117½"
Area	77 sq. ft.	85 sq. ft.	95 sq. ft.	108 sq. ft.	114½ sq. ft.	125 sq. ft.
SHIPPING DATA						
Net weight	8100 lbs.	8400 lbs.	10200 lbs.	10500 lbs.	10750 lbs.	11000 lbs.
Gross weight, domestic	9100 lbs.	9400 lbs.	11550 lbs.	11850 lbs.	12100 lbs.	12350 lbs.
Gross weight, export	9450 lbs.	9750 lbs.	11850 lbs.	12150 lbs.	12400 lbs.	12650 lbs.

CINCINNATI DIAL TYPE MILLING MACHINES

DIMENSIONAL DRAWINGS

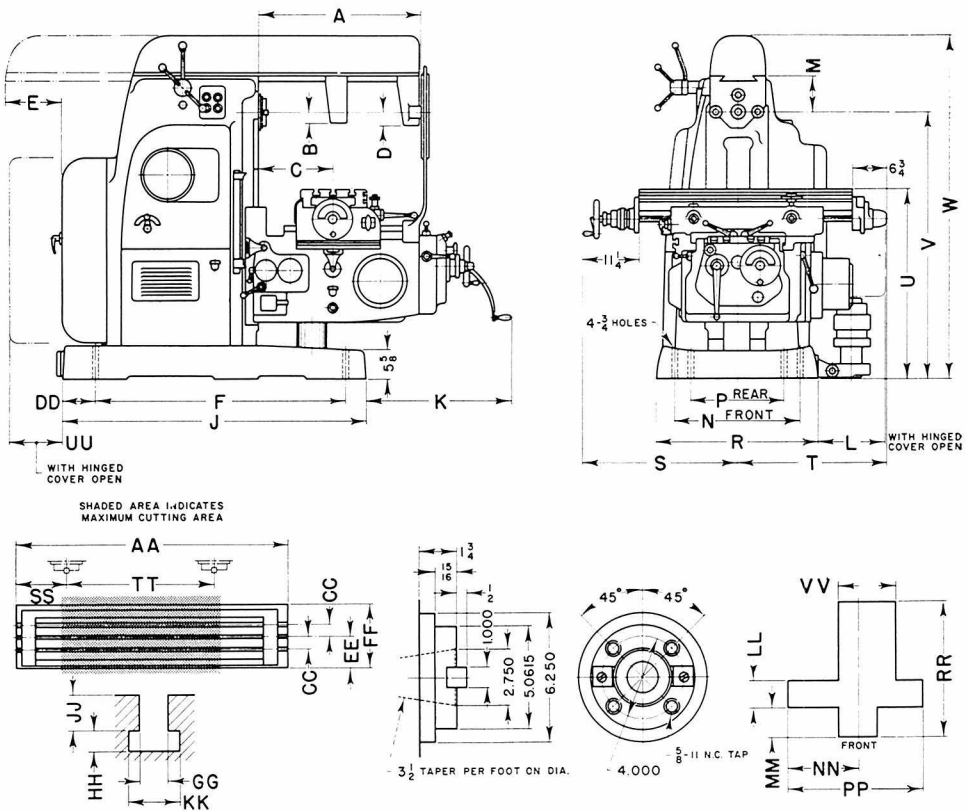


TABLE & TEE SLOT

SPINDLE NOSE

FLOOR PLAN

SIZE OF MACHINE	A	B	*C		D	E	F	J	K	L	M	N	P	R	S		T	
			Min.	Max.											Min.	Max.	Min.	Max.
210-12	31	7 1/2	9 3/4	19 3/4	1 1/8	16 1/8	45 3/8	59 1/2	27 3/8	18 3/4	7 3/8	27	18	31 1/2	26 1/8	54 1/8	22 3/8	50 3/8
310-12	31	7 1/2	9 3/4	21 3/4	2 1/2	16 1/8	45 3/8	59 1/2	27 3/8	18 3/4	7 3/8	27	18	31 1/2	26 1/8	60 1/8	22 3/8	56 3/8
315-15	34 1/8	1 1/8	11 1/8	23 3/8	2 1/2	19 1/4	56 1/4	68	26 1/8	20 1/2	8 3/8	28	21	34	27 3/4	61 3/4	24 3/4	58 3/4
415-15	34 1/8	1 1/8	11 1/8	25 3/8	2 1/2	19 1/4	56 1/4	68	26 1/8	20 1/2	8 3/8	28	21	34	27 3/4	69 3/4	24 3/4	66 3/4
420-16	39	1 1/8	12	26	2 1/2	24	56 1/4	68	31 1/2	20 1/2	8 3/8	28	21	34	27 3/4	69 3/4	28	70
520-16	39	1 1/8	12	28	2 1/2	24	56 1/4	68	31 1/2	20 1/2	8 3/8	28	21	34	27 3/4	77 3/4	28	78

SIZE OF MACHINE	U		V	W	AA	CC	DD	EE	FF	GG	HH	JJ	KK	LL	MM	NN	PP	RR	SS	TT	UU	VV
	Min.	Max.																				
210-12	33 3/8	51 3/8	51 3/8	66 3/8	59 1/2	2 3/8	6 3/8	6	12 3/4	1 1/8	1 1/4	3/8	1 1/4	23	23	55 3/8	105 3/4	104 3/8	15 1/8	28	17 1/2	45
310-12	33 3/8	51 3/8	51 3/8	66 3/8	65 1/4	2 3/8	6 3/8	6	12 3/4	1 1/8	1 1/4	3/8	1 1/4	25	21	61 3/8	117 3/4	104 3/8	15 1/8	34	17 1/2	45
315-15	35 3/8	54 3/8	54 3/8	71 3/8	68 3/2	3 3/4	5 3/8	7 1/2	15 1/4	1 3/8	3/8	1	1 1/2	28	21 3/8	62	121	113 3/4	16 1/2	34	18 3/8	54 3/8
415-15	35 3/8	54 3/8	54 3/8	71 3/8	76 1/2	3 3/4	5 3/8	7 1/2	15 1/4	1 3/8	3/8	1	1 1/2	30	19 3/8	70	137	117 3/8	16 1/2	42	18 3/8	54 3/8
420-16	35 3/8	54 3/8	54 3/8	71 3/8	79 3/4	3 3/4	5 3/8	8	16 1/4	1 3/8	3/8	1	1 1/2	31	22 3/8	70	140 1/2	117 3/8	16 1/2	42	18 3/8	54 3/8
520-16	35 3/8	54 3/8	54 3/8	71 3/8	87 3/4	3 3/4	5 3/8	8	16 1/4	1 3/8	3/8	1	1 1/2	31	22 3/8	78	156 1/4	117 3/8	16 1/2	50	18 3/8	54 3/8

*Maximum dimension C is without overarm brace.

Figure 10A—Dimensional Drawing—Universal Machines

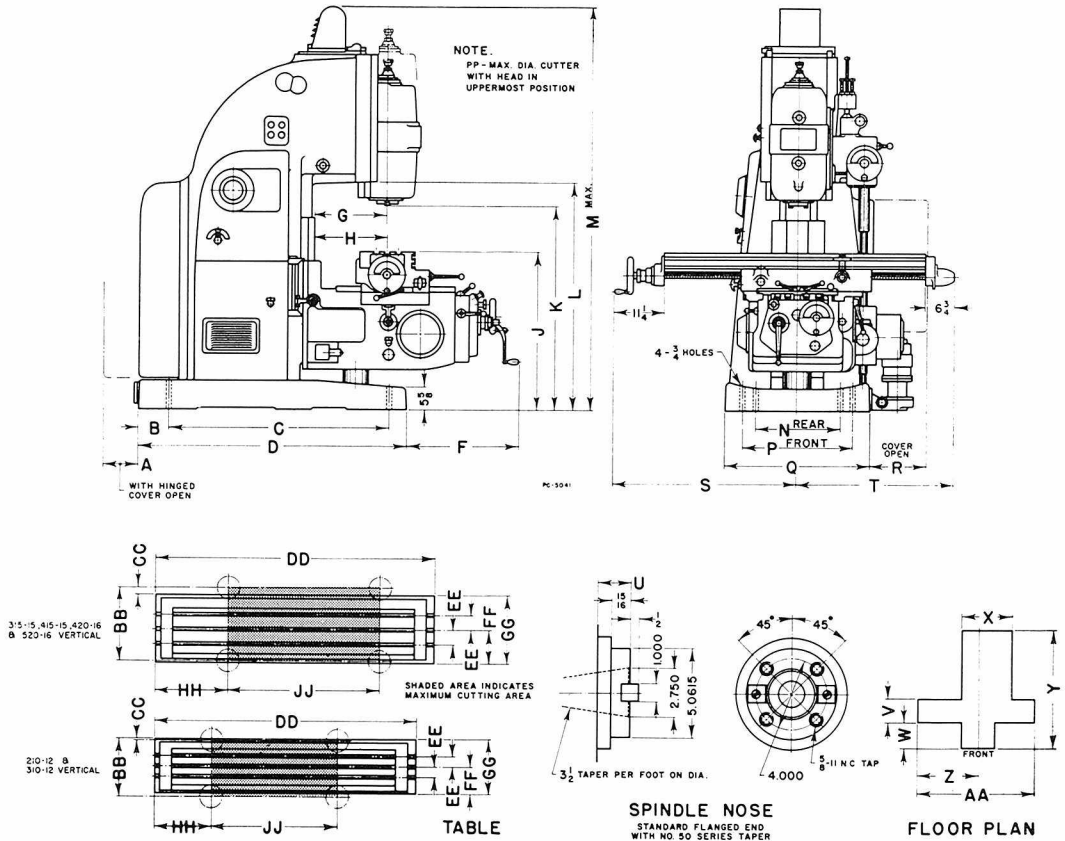
MACHINE SPECIFICATIONS

GENERAL SPECIFICATIONS

SIZE and STYLE	210-12	310-12	315-15	415-15	420-16	520-16
TABLE						
Working surface	59¼"x12¼"	65¼"x12¼"	68½"x15¼"	76½"x15¼"	79¾"x16¼"	87¾"x16¼"
Size overall	59¼"x12¼"	65¼"x12¼"	68½"x15¼"	76½"x15¼"	79¾"x16¼"	87¾"x16¼"
T-slots, number and size	Three—¾"	Three—¾"	Three—¾"	Three—¾"	Three—¾"	Three—¾"
Distance between T-slots	2¾"	2¾"	3¼"	3¼"	3¼"	3¼"
Swivels, right and left	45°	45°	45°	45°	45°	45°
RANGE						
Longitudinal	28"	34"	34"	42"	42"	50"
Cross	10"	12"	12"	14"	14"	16"
Vertical	18"	18"	19"	19"	19"	19"
Centerline spindle to top of table						
Max.	18"	18"	19"	19"	19"	19"
Min.	0"	0"	0"	0"	0"	0"
SPINDLE						
Spindle nose	No. 50 Std.	No. 50 Std.	No. 50 Std.	No. 50 Std.	No. 50 Std.	No. 50 Std.
Hole for draw-in bolt	1½"	1½"	1½"	1½"	1½"	1½"
{ Number	24	24	24	24	24	24
{ Range	18-1800 rpm	18-1800 rpm	16-1600 rpm	16-1600 rpm	16-1600 rpm	16-1600 rpm
No. 210-12 and 310-12 Machines—18, 21, 27, 32, 40, 47, 58, 70, 88, 105, 128, 153, 210, 251, 315, 377, 462, 552, 680, 812, 1020, 1220, 1485 and 1800 rpm.						
Nos. 315-15, 415-15, 420-16 and 520-16 Machines—16, 19, 24, 29, 35, 42, 52, 62, 78, 93, 114, 136, 188, 221, 280, 334, 410, 489, 605, 720, 906, 1080, 1325 and 1600 rpm.						
FEEDS						
Number of feeds	32	32	32	32	32	32
Range { Longitudinal and cross	¾"-90"/min.	¾"-90"/min.	¾"-90"/min.	¾"-90"/min.	¾"-90"/min.	¾"-90"/min.
{	¾, ¾, ¾, ¾, ¾, 1½, 1½, 1½, 1½, 2¼, 2½, 3¼, 3¾, 4½, 5¼, 6½, 7½, 9, 11, 13, 15½, 19, 22,					
{ Vertical	¾"-45"/min.	¾"-45"/min.	¾"-45"/min.	¾"-45"/min.	¾"-45"/min.	¾"-45"/min.
Vertical rates are ½ longitudinal rates.						
DIVIDING HEAD						
Size	10"	12"	12"	14"	14"	14"
Maximum length work between centers	28"	36½"	36½"	52½"	52½"	60½"
Lead Range { Standard leads	2½"-100"	2½"-100"	2½"-100"	2½"-100"	2½"-100"	2½"-100"
{ Low leads	.010"-1000"	.010"-1000"	.010"-1000"	.010"-1000"	.010"-1000"	.010"-1000"
POWER RAPID TRAVERSE						
Longitudinal and cross	150"/min.	150"/min.	150"/min.	150"/min.	150"/min.	150"/min.
Vertical	75"/min.	75"/min.	75"/min.	75"/min.	75"/min.	75"/min.
OVERARM (Dynapoise)						
Underside to centerline of spindle	6½"	6½"	7¾"	7¾"	7¾"	7¾"
DRIVE						
Spindle drive motor	10 hp	10 hp	15 hp	15 hp	20 hp	20 hp
Feed drive motor	3 hp	3 hp	3 hp	3 hp	3 hp	3 hp
FLOOR SPACE						
Maximum size	105¼"x104¼"	117¾"x104¼"	121"x113¼"	137"x113¼"	140½"x117½"	156¼"x117½"
Area	77 sq. ft.	85 sq. ft.	95 sq. ft.	108 sq. ft.	114½ sq. ft.	125 sq. ft.
SHIPPING DATA						
Net weight	8550 lbs.	8850 lbs.	10800 lbs.	11100 lbs.	11400 lbs.	11650 lbs.
Gross weight, domestic	9650 lbs.	9950 lbs.	12200 lbs.	12500 lbs.	12800 lbs.	13050 lbs.
Gross weight, export	9900 lbs.	10200 lbs.	12450 lbs.	12750 lbs.	13050 lbs.	13300 lbs.

CINCINNATI DIAL TYPE MILLING MACHINES

DIMENSIONAL DRAWINGS



SIZE OF MACHINE	A	B	C	D	F	G	H		J		K		L	M	N	P	Q	R	S		T	
							Min.	Max.	Min.	Max.	Min.	Max.							Min.	Max.	Min.	Max.
210-12	17 1/2	6 1/8	45 3/4	59 1/2	27 3/8	16	9 1/8	21 3/8	31 3/8	44 3/8	45 3/8	51 3/8	50 3/8	88 3/8	18	27	31 1/2	18 3/4	24 3/8	52 3/8	24 3/8	52 1/8
310-12	17 1/2	6 1/8	45 3/4	59 1/2	27 3/8	16	9 1/8	21 3/8	31 3/8	44 3/8	45 3/8	51 3/8	50 3/8	88 3/8	18	27	31 1/2	18 3/4	24 3/8	58 3/8	24 3/8	58 1/8
315-15	18 3/4	5 7/8	56 1/4	68	31 1/2	18	11 1/8	27 3/8	33 1/2	49 1/2	49 3/8	55 3/8	54 3/8	97 3/4	21	28	34	20 1/2	27 3/4	61 3/4	24 3/4	58 3/4
415-15	18 3/4	5 7/8	56 1/4	68	31 1/2	18	11 1/8	27 3/8	33 1/2	49 1/2	49 3/8	55 3/8	54 3/8	97 3/4	21	28	34	20 1/2	27 3/4	69 3/4	24 3/4	66 3/4
420-16	18 3/4	5 7/8	56 1/4	68	31 1/2	18	11 1/8	27 3/8	33 1/2	49 1/2	49 3/8	55 3/8	54 3/8	97 3/4	21	28	34	20 1/2	27 3/4	69 3/4	28	70
520-16	18 3/4	5 7/8	56 1/4	68	31 1/2	18	11 1/8	27 3/8	33 1/2	49 1/2	49 3/8	55 3/8	54 3/8	97 3/4	21	28	34	20 1/2	27 3/4	77 3/4	28	78

SIZE OF MACHINE	U	V	W	X	Y	Z	AA	BB	CC	DD	EE	FF	GG	HH	JJ	PP
210-12	1 1/32	25	21	45 3/8	104 3/8	52 3/8	105 3/4	12	1 3/8	59 3/4	2 3/8	6	12 3/4	13 3/8	28	10
310-12	1 1/32	25	21	45 3/8	104 3/8	58 3/8	117 3/4	12	1 3/8	65 3/4	2 3/8	6	12 3/4	13 3/8	34	10
315-15	1 3/8	32	22 3/4	54 3/8	118 3/4	62	121	16	1 3/8	68 1/2	3 3/4	7 1/2	15 3/4	16 1/2	34	10 1/2
415-15	1 3/8	32	22 3/4	54 3/8	118 3/4	70	137	16	1 3/8	76 1/2	3 3/4	7 1/2	15 3/4	16 1/2	42	10 1/2
420-16	1 3/8	33	21 3/4	54 3/8	118 3/4	70	140 1/4	16	1 1/4	79 3/4	3 3/4	8	16 1/4	16 1/2	42	10 1/2
520-16	1 3/8	33	21 3/4	54 3/8	118 3/4	78	156 1/4	16	1 1/4	87 3/4	3 3/4	8	16 1/4	16 1/2	50	10 1/2

Figure 12A
Dimensional Drawing—Vertical Machines

GENERAL SPECIFICATIONS

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STANDARD EQUIPMENT Supplied with the Machine

Plain, Universal, and Vertical Machines:

Complete Electrical Equipment for 50 or 60 cycle, 2 or 3 phase, 220 to 550 volts A.C. and wired in accordance with "Machine Tool Electrical Standards".

Spindle Drive Motor: Open, normal torque, low starting current, N.E.M.A. frame, ball bearing. See page 9, 11, and 13 for motor rating.

Feed Drive Motor: 3 H. P., Flange type frame.

Controls: Full voltage magnetic starter with overload and undervoltage protection including transformer and push buttons operated at 110 volts.

Disconnect Switch: Built in and mechanically interlocked with electrical compartment door.

Plain Machines:

Arbor Supports: Two supplied. One Style "B" with $2\frac{1}{8}$ " adjustable arbor bushing and provided with lugs for brace. One Style "B" with $2\frac{1}{8}$ " adjustable arbor bushing without lugs for brace and equipped with Arbor Support Bushing Adapter M-01 for Style "A" arbors. At the time the order is placed Style "A" Arbor Support with adjustable bushing for pilot end arbors may be substituted for completely fitted style "B" without lugs.

Rear Hand Adjustment and Rear Power Feed Controls: Longitudinal cross and vertical.

Motor Driven Cutting Fluid Pump.

Automatic Table Feed Cycles: (Automatic cycle machines only).

Adjustable Table Control Dogs: Machines without automatic cycles—two feed trip dogs. Machines with automatic cycles—2 feed, 2 rapid traverse, 2 reverse, 1 end stop and 1 center safety stop.

Automatic Backlash Eliminator.

Standard Feed Range: $\frac{3}{8}$ " to 90" per min.

Wrenches.

Arbor Draw-in Bolt.

Overarm Brace.

Arbor-Loc Spindle Nose Arrangement.

Universal Machines:

Arbor Supports: Two supplied. One Style "B" with $2\frac{1}{8}$ " adjustable arbor bushing and provided with lugs for brace. One Style "B" with $2\frac{1}{8}$ " adjustable arbor bushing without lugs for brace and equipped with Arbor Support Bushing Adapter M-01 for Style "A" arbors. At the time the order is placed Style "A" Arbor Support with adjustable bushing for pilot end arbors may be substituted for completely fitted style "B" without lugs.

Standard Universal Dividing Head with No. 50 standard taper hole in spindle. Equipment includes tailstock with 2-point adjustable center; steady rest, one plate for indexing through 40 to 1 reduction—all numbers up to and including 60, all even numbers and those divisible by 5 up to 120, and many beyond; direct indexing on spindle nose; one center for headstock; and provision for connecting head to enclosed driving mechanism

segment. Sizes (nominal swing); 10", 12" and 14".

Enclosed Driving Mechanism Segment, including change gears for spiral milling for Standard Universal Dividing Heads. Standard leads, $2\frac{1}{2}$ " to 100".

Rear Hand Adjustment and Rear Power Feed Controls: Longitudinal cross and vertical.

Motor Driven Cutting Fluid Pump.

Automatic Backlash Eliminator.

Standard Feed Range: $\frac{3}{8}$ " to 90" per min.

Wrenches.

Arbor Draw-in Bolt.

Overarm Brace.

Arbor-Loc Spindle Nose Arrangement.

Vertical Machines:

Power Feed and Power Rapid Traverse to Vertical Head.

Turret Stop Four-position with dial indicator.

Rear Power Feed Control: Longitudinal only.

Motor Driven Cutting Fluid Pump.

Automatic Table Feed Cycles. (Automatic cycle machines only).

Adjustable Table Control Dogs: Machines without automatic cycles—two feed trip dogs. Machines with automatic cycles—2 feed, 2 rapid traverse, 2 reverse, 1 end stop and 1 center safety stop.

Automatic Backlash Eliminator.

Standard Feed Range: $\frac{3}{8}$ " to 90" per min.

Arbor Draw-in Bolt.

Wrenches.

Arbor-Loc Spindle Nose Arrangement.

INSTALLATION INSTRUCTIONS

To obtain accurate results from a milling machine over a long period of time, three requirements must be met. First, the foundation upon which the machine rests must be heavy enough to maintain stability and flatness under the weight of the machine. Second, the machine must be firmly anchored to the foundation; and third, the machine must be carefully leveled and then checked occasionally to be sure that level is maintained.

Foundation. Special foundations for CINCINNATI Dial Type Milling Machines are not required. Any substantial floor, wood or concrete, fairly flat, and sufficiently heavy to withstand the weight of the machine, will be satisfactory. See specifications, pages 9, 11 and 13, for weights and dimensions.

Lifting the Machine. The machine may be lifted by a crane with a rope or cable sling around the overarm (Horizontal Machines) or around the throat (Vertical Machines), Figures 15A and 15B. If a wire cable is used, be sure to protect the dovetail bearings with wood blocks. On Horizontal Machines tighten the overarm clamping lever before lifting. Before lifting Vertical Machines, adjust saddle to front of knee to balance the weight.

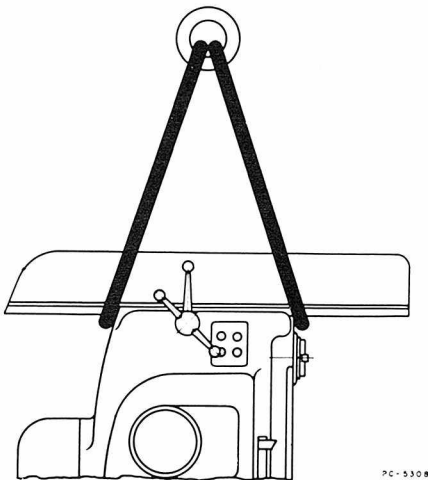


Figure 15A
Lifting the Plain and Universal
Machines

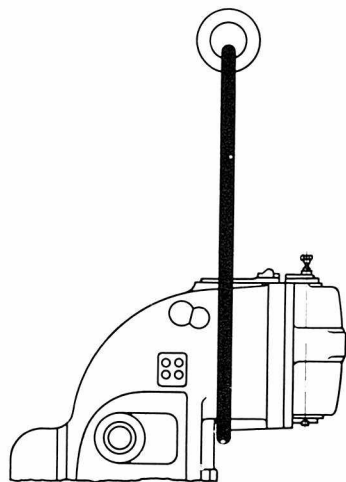


Figure 15B
Lifting the Vertical Machine

CINCINNATI DIAL TYPE MILLING MACHINES

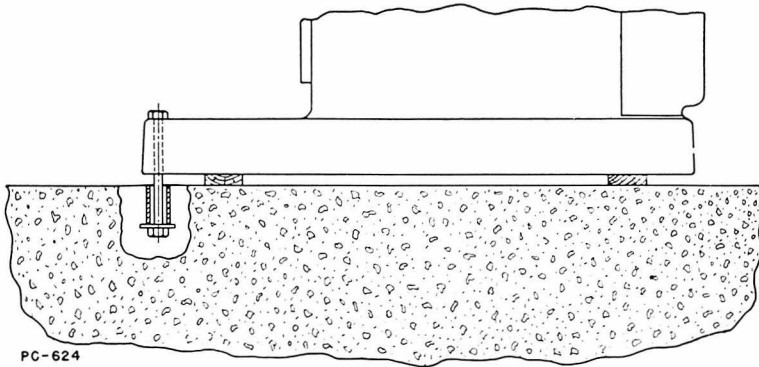


Figure 16A
Bolting the Machine to a Concrete Floor

Bolting the Machine to the Floor. When preparing for this operation, notice that center distances of bolt holes, given on the data sheet accompanying the machine, are approximated. If the floor is concrete, drill the bolt holes about 6" in diameter. Insert the hold-down bolt through a 1½" pipe, as illustrated in Figure 16A, and fill the pipe with dry sand. Lower the machine on two 1" thick boards, and engage the nuts on two or three threads of the bolts. Fill the holes around the pipe with quick drying cement, thin enough to flow easily. When cement is dry, remove boards, level machine and tighten hold-down nuts.

Leveling. After the machine has been moved to its proper location, it must be carefully leveled. Use an accurate level for this operation. A carpenter's level or the bulb in a machinist's combination square is not good enough. Place laminated shims under the bearing pads of the base, alternating metal and felt shims, until the table is level in both directions. Shims should be large enough so entire bearing pad, under the base, is resting on the shim, to evenly distribute the weight of the machine. It is necessary, that the machine table and leveling instrument be absolutely clean and free of burrs to obtain the most accurate result.

Assembling Table to Machine. If the machine table and leadscrew have been removed for convenience in shipping the following instructions must be adhered to when reassembling machine table and leadscrew.

INSTALLATION INSTRUCTIONS

Important. Never remove the backlash eliminator housing and do not disturb the relationship between the two steel adjusting nuts and the bronze leadscrew nuts. Backlash eliminator disengaging knob should be in disengaged position (see page 33) before assembling table to machine.

1. Remove wire which holds two backlash eliminator nuts in housing. Remove one bronze leadscrew nut at a time, clean and replace.
2. Push in right-hand nut (as viewed from front of machine) and align scribed line on nut with line on housing by turning nut against spring tension. Insert leadscrew from right-hand end of machine. Make sure nut is held tight against housing and also that scribed lines are kept aligned while inserting leadscrew. Turn leadscrew until its end is just through right-hand nut.
3. Push in left-hand nut and align scribed line on nut with line on housing. Turn leadscrew into left-hand nut. *Make sure that both nuts are held tight against housing and also that scribed lines on both nuts are kept aligned with lines on housing.* Turn leadscrew in far enough so that it passes completely through left-hand nut.
4. Wash bearing surfaces on the saddle and table perfectly clean. Apply a liberal coat of machine oil to saddle bearings.
5. Place table control lever in its neutral or middle position.
6. Insert two table locking shoes in holes in front of saddle and follow up with table clamping screws.
7. Insert table from the left-hand side of machine.
8. Insert table gib between saddle and table and adjust gib (see page 43)
9. Turn leadscrew in until apron on right-hand end of leadscrew is tight against right-hand end of table. Be sure dowel pins in apron match with pin holes in end of table. Insert and tighten apron screws.
10. Attach left-hand apron to left-hand end of table. Adjust the adjusting nut on right-hand end of leadscrew to take up end play in leadscrew. There should not be more than .005" backlash in leadscrew dial. Tighten lock screw in adjusting nut.
11. Place clutch, dial, spring, handwheel, etc. on left-hand end of leadscrew. Check table movement by turning hand crank. If too tight or too loose, re-adjust gib.

CINCINNATI DIAL TYPE MILLING MACHINES

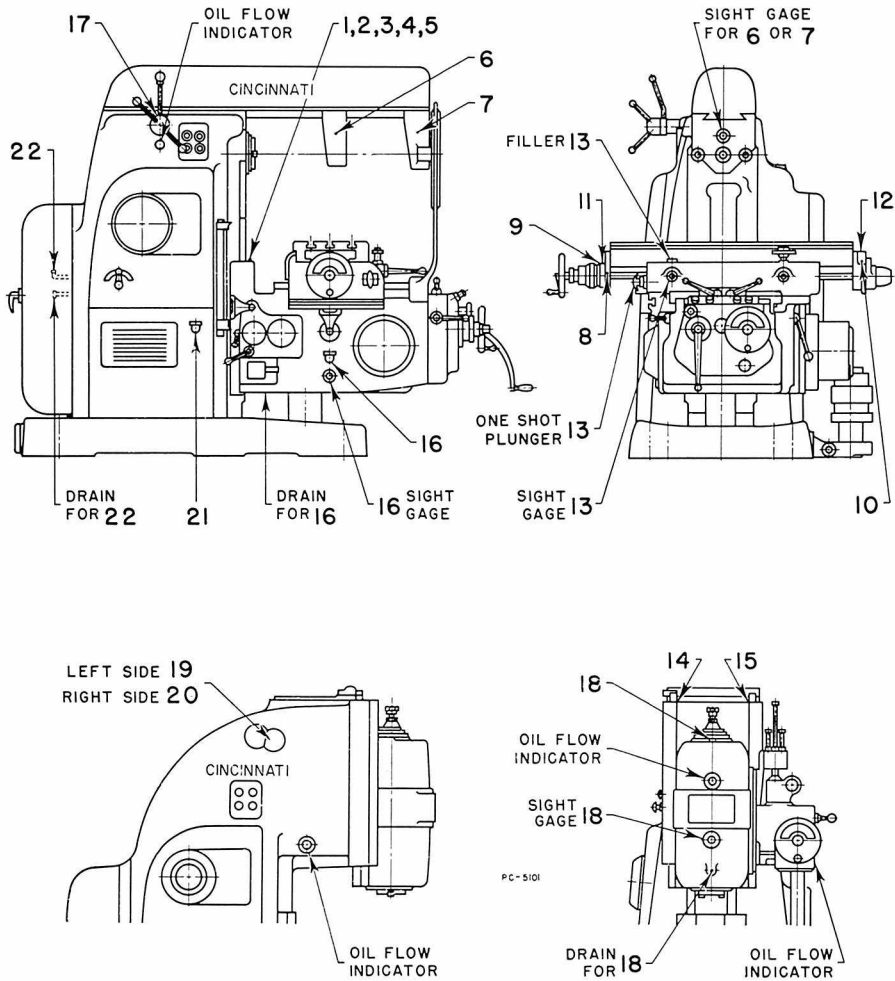


Figure 18A
Lubrication Diagram

LUBRICATION INSTRUCTIONS

LUBRICATING INSTRUCTIONS AND SPECIFICATIONS

See Lubrication Diagrams, page 18.

Thoroughly oil all moving parts as they are installed. Then, lubricate all principal points as listed below before starting machine. Periodic and thorough lubrication with correct lubricant, as specified, will help maintain the long life and accuracy built into machine. The intervals listed are based on a normal eight-hour day.

PURCHASE LUBRICANTS FROM RELIABLE DEALERS

When to Oil	Station Number	Instructions	Parts Lubricated	Specifications
Daily	1, 2, 3, 4, and 5	Spring cup oil cups. Keep filled, use bench oiler to fill. (Five stations).	Knee-column vertical ways.	P-55. Good quality paraffinic base rust and oxidation inhibited oil. Viscosity range 200-220 S.U.S. @ 100° F.
	6 and 7	*Remove cap, keep filled to high limit. Use oil pot to fill. (Check daily).	Arbor support bearings.	
	9 and 10	Spring cap oil cups. Keep filled, use bench oiler to fill.	Table leadscrew bearings.	
	11 and 12	Spring cap oil cup and oil button. Keep filled. Use bench oiler to fill. (Daily when used).	Auxiliary drive shaft bushings.	
	8	Oil Button. A few drops of oil, use a bench oiler.	Automatic knockout shaft bearing for hand control wheel for table feed.	
	13	*Keep filled above low limit on gage. Use oil pot to fill. Pull handle six times twice daily and allow to return by itself. (Check daily).	Table—saddle ways saddle-knee ways and under saddle bracket and cross feed screw.	
	14 and 15	Spring cap oil cups. Keep filled, use bench oiler to fill.	Column—head vertical bearing ways.	
Weekly	16	*Keep filled above low limit on gage. Use oil pot to fill (Check weekly).	Gears and bearings in knee.	P-64. Lithium base grease NLGI No. 2 consistency.
	17	Oil button. Apply 2 or 3 drops, use bench oiler.	Overarm pilotwheel bearings.	
	18	*Remove cap. Keep filled to high limit on gage, use oil pot to fill. (Check weekly).	Gears and bearings in vertical head.	
	22	*Open main motor drive cover. Remove cap, keep filled to threads on pipe fitting. Use oil pot to fill. (Check weekly).	Gears and bearings in column.	
	19 and 20	Apply 1 or 2 shots with a hand grease gun.	Counterweight sprocket shaft bearings.	
	21	*Remove cap, keep filled to threads on pipe fitting. Use oil pot to fill. (Check weekly).	Vertical screw.	P-63. EP Lead Naphthenate type oil, viscosity range 300 to 360. S.U.S. @ 100° F.

*Quantity required: Station No. 6 or No. 7 approx. 1 qt., Station No. 13 all machines approx. 1 qt., Station No. 16, No. 210-12 and 310-12 machines approx. 6 gals. No. 315-15 approx. 8 gals., 415-15 and No. 420-16 and 520-16 machines approx. 10 gals., Station No. 18 all machines approx. 1½ qts., Station No. 21 Horizontals approx. 5 pts. Verticals approx. 6 pts., Station No. 22 Horizontals—No. 210-12 and 310-12 approx. 2 gals; No. 315-15, 415-15, 420-16 and 520-16 approx. 3½ gals; all Verticals—approx. 10 gals.

Note—Lubricate motor according to motor manufacturer's specifications.

P-63, P-55 and P-64 are The Cincinnati Milling Machine Co. Specifications Numbers.

STARTING THE MACHINE FOR THE FIRST TIME

After the machine has been properly installed, wash off the slushing oil and dirt accumulated in transit with naphtha or a similar solvent of grease. Then fill all oiling stations with the grade of lubricant specified (See page 19).

Before assembling the V-belts to the motor, turn it over by hand a few times to be sure that it rotates freely, and that no foreign materials have fallen into the motor during shipment or while being unpacked.

Start the motor only, and immediately notice the direction of rotation of the driving pulley at the rear of the machine. To start the motor with the hinged belt guard cover open, the safety switch, Figure 51A, must be held in contact by hand while the regular starting button is pushed. The motor must rotate clockwise, as indicated by the plate (Figure 20A) attached to the pulley.

Run the machine for a half hour or so to insure a protective film of oil is obtained over all bearings, and apply oil frequently during this period. Do not fill the reservoirs while the machine is running.

When the machine is running make sure that all reservoirs are full. Also, check to make sure that oil is visible in each of the oil flow gages—see Figure 18A for location of flow gages. If the oil is not visible, immediately stop the machine and check the reservoir and system.

Note in particular the saddle-table oil-shot lubrication system, station 13, Figure 18A. The oil level in this reservoir must be above the low limit at all times. If the oil is completely exhausted, air will get into the system, and it will be necessary to operate the pump several times to expel the air.

Pull the plunger out the full length of its stroke and allow it to return itself. *Do not push.*

If the machine is located in an extremely dusty atmosphere, as sometimes found near cutter sharpening machines, the table dovetail, knee-column bearing, saddle-knee bearing, and vertical head-column bearing (Vertical Machines only), should be wiped clean twice a day. After cleaning, apply oil to the bearing surfaces.

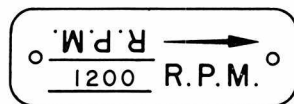


Figure 20A
Main Drive Pulley Must
Rotate in This Direction
Viewed From Rear of
Machine
(Plate shown is for Nos.
2 and 3 Machines)

OPERATING INSTRUCTIONS

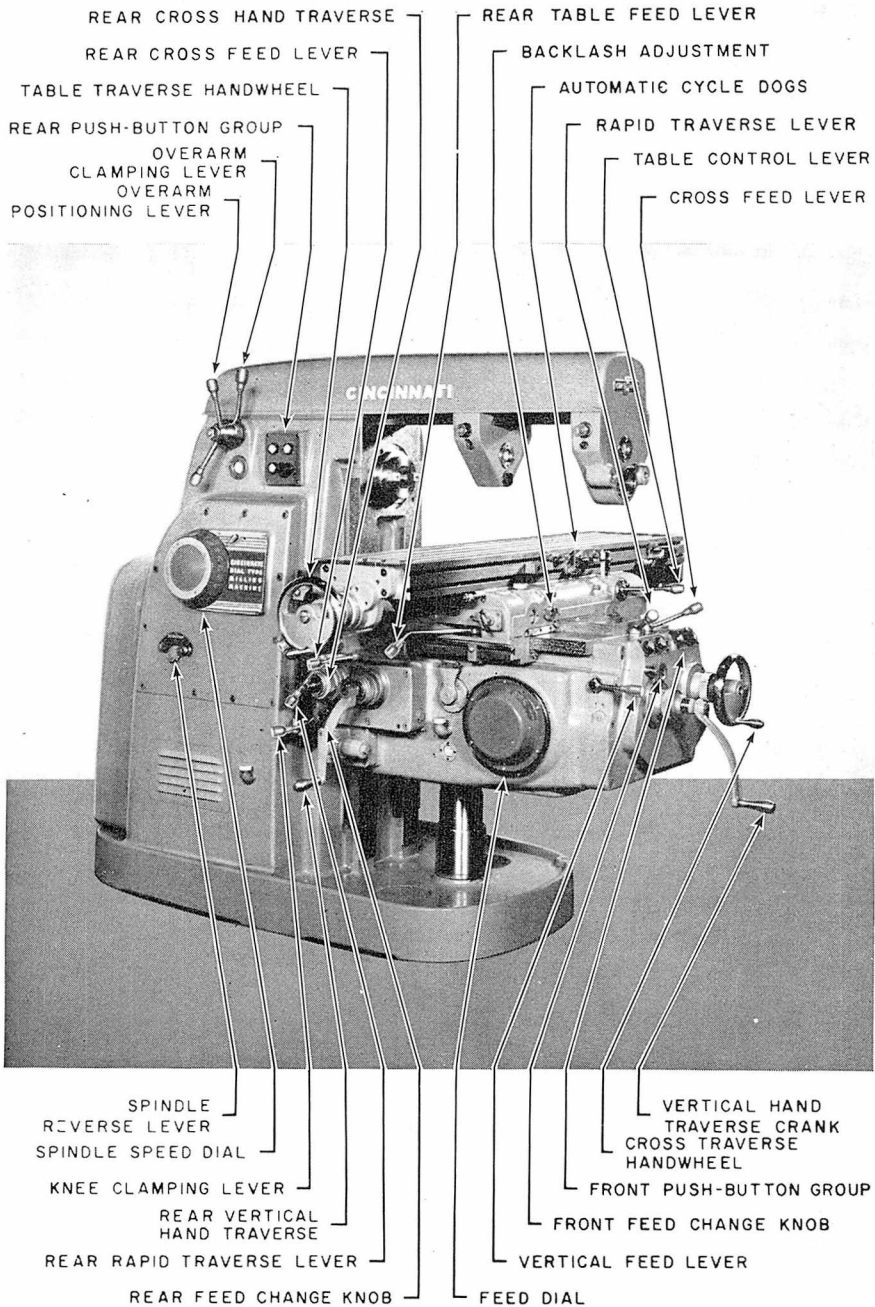


Figure 21A
View of Plain Dial Type Milling Machine with Automatic Table Cycles
Showing Operating Controls.

OPERATING INSTRUCTIONS

Starting the Machine. Place the cross, vertical and table feed levers in their neutral or stop positions (Figure 24A). Start the motor. **Note**—The hinged belt guard cover at the rear of the machine must be closed and latched before the push button will start the motor. Depress the "Spindle Start" button to start the rotation of the spindle. An automatic spindle brake is thrown into engagement when the "Spindle Stop" button is depressed to stop the rotation of the spindle.

Changing Spindle Speeds. Start the motor. With the spindle stationary, depress and hold the "Speed Increase" or "Speed Decrease" push button (Figure 23A). This action will cause the spindle speed dial (Figure 21A) to rotate. When the speed desired, shown on the spindle speed dial, registers with the index mark, release the push button. Now, pause a second or two and then depress the "Spindle Start" button. The spindle will rotate at the speed indicated by the dial and index mark. The short pause mentioned previously gives the gears time to fully engage, and thereby, prevents clashing of the teeth.

When working from the rear of the machine, the speed dial and spindle start-stop is controlled by the group of push buttons located on the column.

Note: *On long run jobs, change speeds one full rotation of dial each day.*

Nos. 210-12 and 310-12	18, 21, 27, 32, 40, 47, 58, 70, 88, 105, 128, 153, 210, 251, 315, 377, 462, 552, 680, 812, 1020, 1220, 1485, and 1800 rpm
Nos. 315-15 415-15, 420-16 and 520-16	16, 19, 24, 29, 35, 42, 52, 62, 78, 93, 114, 136, 188, 221, 280, 334, 410, 489, 605, 720, 906, 1080, 1325, and 1600 rpm

Figure 22A—Standard Spindle Speeds

Micrometer Dials. All of the hand controls, longitudinal, cross, and vertical, are provided with adjustable micrometer dials. To reset, or "zero", one of these dials, pull it outward against light spring pressure, rotate to the desired position and release.

Hand Table Feed. The table traverse handwheels (Figure 21A), located at each end of the table, control the movement of the table when the power feed is disengaged. When the handwheel is rotated one turn in a clockwise direction, the table moves away from the operator $\frac{1}{4}$ inch. The dial is graduated into 250 equal spaces, which is equivalent to .001" movement of the table for each space.

Hand Cross Feed. The cross traverse handwheel, (Figures 21A and 23A), enables the saddle to be moved by hand across the top of the knee when working from the front of the machine. One clockwise turn of the handwheel moves the saddle $\frac{1}{4}$ inch toward the column. The dial is graduated into 250 spaces, which is equivalent to .001" movement of the saddle for each space.

OPERATING INSTRUCTIONS

Hand Vertical Feed. The vertical hand traverse crank, (Figures 21A and 23A), enables the knee to be moved up or down when working from the front of the machine. One clockwise turn moves the knee up $\frac{4}{10}$ inch. The dial is graduated into 100 equal spaces, which is equivalent to .001" movement of the knee for each space.

Power Feed Controls. All power feed control levers—longitudinal, cross, and vertical—are of the directional control type, i. e., the sliding unit moves in the direction in which the lever is moved. For instance, if the table power feed lever is moved to the left, the table moves to the left; if the lever is moved to the right, the table is moved to the right.

Note—The Plain and Universal Machines are also equipped with complete rear power feed controls. See "Rear Power Feed Controls", page 26.

Power Table Feed. Longitudinal power movements of the table are engaged from the front of the machine by means of the table control lever (Figures 21A and 23A). To feed the table left, move the lever to the left; to feed the table right, move the lever to the right. Power rapid traverse is obtained by first engaging the power table feed and then engaging the rapid traverse lever (Figures 21A and 23A). Be certain that you loosen the table clamping screws before engaging the table feed or rapid traverse. It is also advisable to tighten the saddle and knee clamp when using the table feed alone. See "Clamping Devices for Sliding Units", pages 32 and 33.

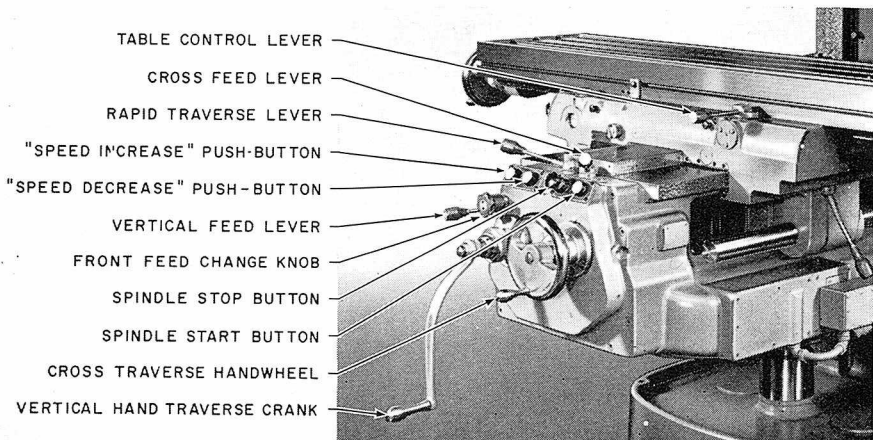


Figure 23A
Right Hand View of Knee

CINCINNATI DIAL TYPE MILLING MACHINES

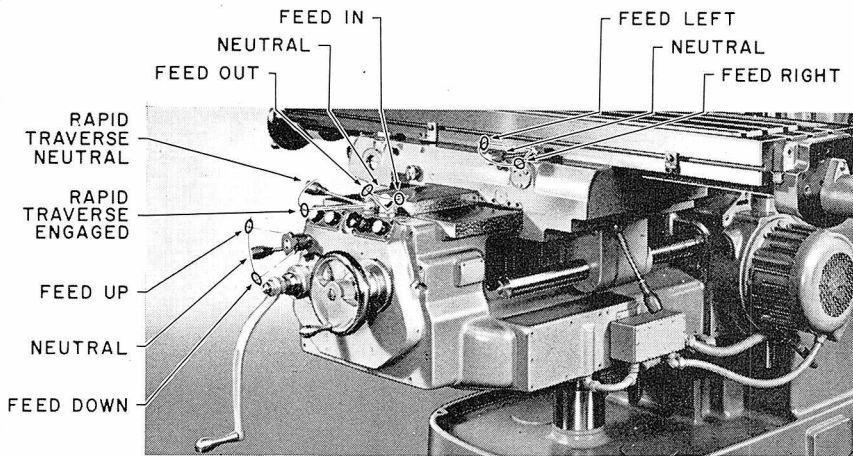


Figure 24A

Engaged and Neutral Positions of Front Control Power Feed Levers

Power Cross Feed. Traverse power feed movements of the saddle are engaged by means of the cross feed control lever (Figures 21A and 23A). To feed to the rear, shift lever to the rear, to feed to the front, shift lever to front. Before engaging the cross feed, loosen the saddle clamp. It is also advisable to tighten the table clamping screws and knee clamp when using the cross feed. See "Clamping Devices for Sliding Units", pages 32 and 33.

Power Vertical Feed. Vertical power feed movements of the knee are engaged by means of the vertical feed control lever (Figures 21A and 23A). Shift the lever upward to raise the knee, downward to lower the knee. Before engaging the vertical feed loosen the knee clamp. It is also advisable to tighten the table clamping screws and saddle clamp when using the vertical feed alone. See "Clamping Devices for Sliding Units", pages 32 and 33. Power vertical feed rates are $\frac{1}{2}$ the rates shown on the feed dial.

Feeds. The method of changing the feed rates, described below, is similar to the method of changing spindle speeds. If desired, any combination of feed motions, such as cross and table, may be engaged at the same time. The spindle must be running to obtain a feed movement. Reversing the direction of rotation of the spindle (explained on page 30) does not affect the direction of the feeds.

OPERATING INSTRUCTIONS

Changing Feeds. Start the motor. The spindle should be stopped and all front and rear feed engaging levers should be in their neutral or stop positions. Rotate the feed change knob (Figures 21A and 23A) clockwise or counter-clockwise and hold until the desired feed shown on the feed dial (Figure 21A) is registered with the index mark. Release the feed change knob. The proper feed gears are now in mesh to move the table at the feed rate indicated by the dial and index mark.

Each vertical rate of traverse is $\frac{1}{2}$ the feed rate as indicated below.

Table and Cross Feeds	$\frac{3}{8}, \frac{7}{16}, \frac{9}{16}, \frac{11}{16}, \frac{13}{16}, \frac{15}{16}, 1\frac{1}{8}, 1\frac{3}{16}, 1\frac{5}{8}, 1\frac{7}{8}, 2\frac{1}{4}, 2\frac{5}{8}, 3\frac{1}{4}, 3\frac{3}{4}, 4\frac{1}{2}, 5\frac{1}{4}, 6\frac{1}{2}, 7\frac{1}{2}, 9,$ 11, 13, 15 $\frac{1}{4}$, 19, 22, 27, 31, 39, 45, 54, 63, 79, 90 in./min.
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Figure 25A
Standard Feed Rates (Inches/Minute)

Power Rapid Traverse. The power rapid traverse, controlled from the front of the machine by the rapid traverse lever (Figures 21A and 23A), may be engaged at any time and for any direction of travel with the spindle either running or stationary. (Of course, the motor must be running.) The feed lever, which will give the direction of travel desired, must also be engaged at the same time the rapid traverse lever is engaged.

For instance, suppose you want to use the *vertical* rapid traverse. Move the vertical feed lever up or down, according to the direction of travel desired, then hold the rapid traverse lever in its engaged position. The sequence of engaging the levers is an important consideration to insure long life of the rapid traverse clutch—*always engage the feed lever first, especially when using the vertical rapid traverse.*

The rapid traverse rate for the longitudinal and cross movements is 150 inches a minute, while the vertical rate is 75 inches a minute.

Rear Hand Controls. Standard equipment for the Plain and Universal Machines includes rear hand adjustments for the cross and vertical movements, in addition to the table traverse handwheel which also can be operated from the rear. These controls, adjusted by means of a hand crank, easily moved from one shaft to the other, are shown in Figure 26A. The cross traverse dial is graduated into 250 equal spaces, each of which is equal to .001" movement, while the vertical traverse dial is graduated into 100 spaces with each space being equal to .001" movement.

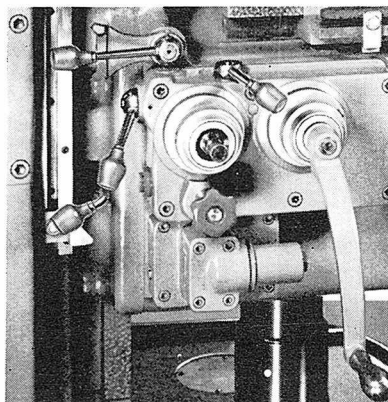


Figure 26A
Rear Hand Controls

Rear Power Feed Controls. Standard equipment for the plain and universal machines includes rear power feed controls for cross, longitudinal, and vertical movements (Figure 26B). The vertical machines include rear power longitudinal control, only.

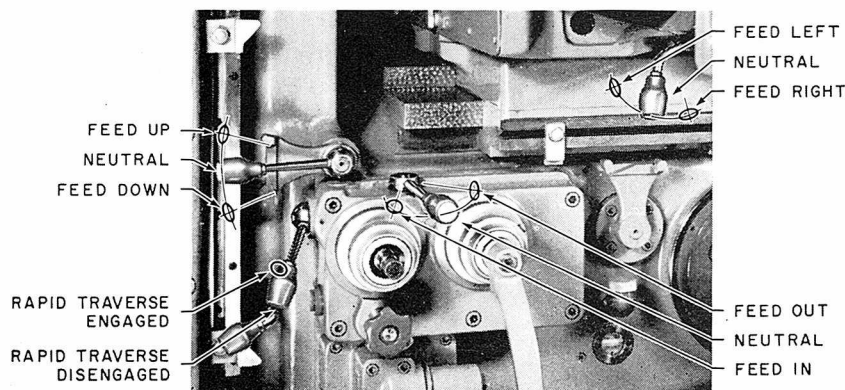


Figure 26B
Rear Power Feed Controls on Plain and Universal Machines

OPERATING INSTRUCTIONS

Like the front table control lever, the rear table control lever has only two operating positions—feed left or feed right. Table rapid traverse is obtained by moving the table feed lever to the right or left, depending upon the direction of travel desired, and then engaging the rapid traverse lever.

Both cross and vertical power levers are provided and, like the table, cross and vertical rapid traverse can be obtained by moving the feed lever to a feed position and then engaging the rear rapid traverse lever.

OPERATING INSTRUCTIONS

Common to Vertical Machines only. Remainder of Operating Instructions are same as for Horizontal Machines

Power feed and rapid traverse for the head of the vertical machines (supplied as standard equipment) is a very handy device for tool room work. It is much more convenient than using the vertical travel of the knee for work requiring a short vertical feed, such as die making, end milling keyways, accurate boring, etc.

Refer to Figure 28A for the operating instructions given on these pages.

Hand Feed to Vertical Head. The vertical head can be moved, by hand, when power feed is disengaged, by rotating the vertical feed handwheel (Figure 28A). One clockwise turn of the handwheel moves the head down $\frac{1}{8}$ inch. The micrometer dial is graduated into 125 spaces, which is equivalent to .001" movement for each space. Be sure that you loosen the hand clamping lever (Figure 28A) before trying to move the vertical head. To reset the micrometer dial, merely loosen the thumbscrew, rotate the dial to the desired setting, and then tighten the screw.

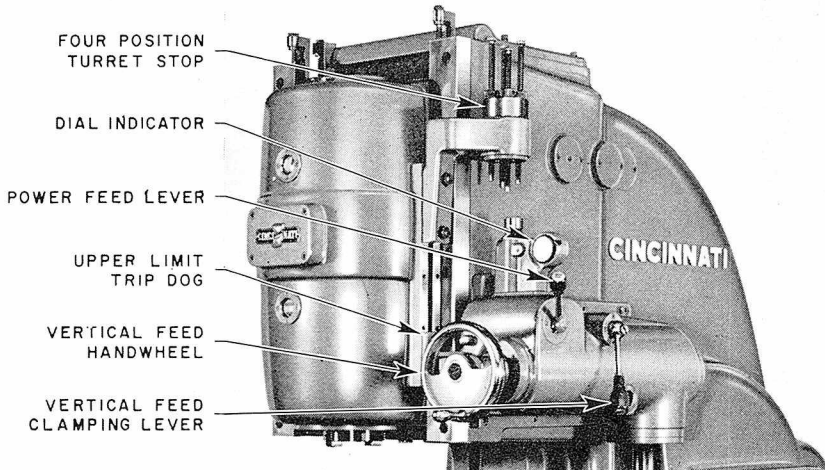


Figure 28A
Vertical Head Showing Hand and Power Feed Controls, Four Position Turret Stop

Power Feed to Vertical Head. Vertical power feed movements of the vertical head are engaged by means of the vertical head power feed lever (Figure 28A). When the lever is moved up, the head moves up; when the

OPERATING INSTRUCTIONS

lever is moved down, the head moves down. Be certain that you loosen the clamping lever before engaging the power feed. The power feed rates to the vertical head are $\frac{1}{2}$ the feed rates shown on the feed dial.

Power Rapid Traverse to Vertical Head. The power rapid traverse to the vertical head is controlled by the vertical head power feed lever in conjunction with the power rapid traverse lever (Figures 21A and 23A). To rapid traverse the head, first move the feed lever in the direction you want the head to move and then engage the rapid traverse lever. Rapid traverse rate to the vertical head is 75 inches per minute.

Clamping the Vertical Head in Position. The vertical head can be rigidly clamped to the column by means of the vertical head clamping lever (Figure 28A) on the right-hand side and a clamping nut on the left-hand side of the head. Be certain that you loosen these clamps before trying to move the head by hand or power.

Four-Position Turret Stop and Dial Indicator. The turret stop and dial indicator, shown in Figure 28A, are standard equipment supplied with all Vertical Dial Type Milling Machines. The turret stop should be used as a *feed* trip only, downward power rapid traverse movement of the head should always be disengaged before the turret stop screw contacts the plunger at the top of the indicator bracket. Failure to do so may result in serious damage to the machine if the head should "coast" after tripping the plunger. After tripping out of feed down, the vertical head should be lowered, by means of the vertical feed handwheel, to accurate final position as shown by the dial indicator. Upward power movements of the vertical head can be disengaged by the upper limit trip dog (Figure 28A).

Rear Hand Adjustments. Rear hand adjustments of knee and saddle for the Vertical Machines can be supplied at extra cost. Operating instructions are the same as for the Horizontal Machines.

Rear Power Feed Controls. Rear power cross and vertical feed controls can be supplied at extra cost on the Vertical Machines. Operating instructions are the same as for the Horizontal Machines. A rear table feed control lever is supplied as standard equipment. With this lever the table feed can be operated from the rear working position. Rapid traverse can be obtained by first engaging the feed lever and then the rapid traverse lever. See Figure 26B for functions of rear controls.

SETTING UP THE MACHINE

Overarm and Arbor Supports. The overarm may be positioned by first loosening the clamping lever and then turning the overarm adjusting crank (Figure 30A). Turning the crank clockwise moves the overarm toward the front of the machine, while turning it counter-clockwise moves the overarm toward the rear. After the overarm is positioned, tighten the hand clamp. Horizontal machines are equipped with a Dynapoise unit which damps self-excited chatter.

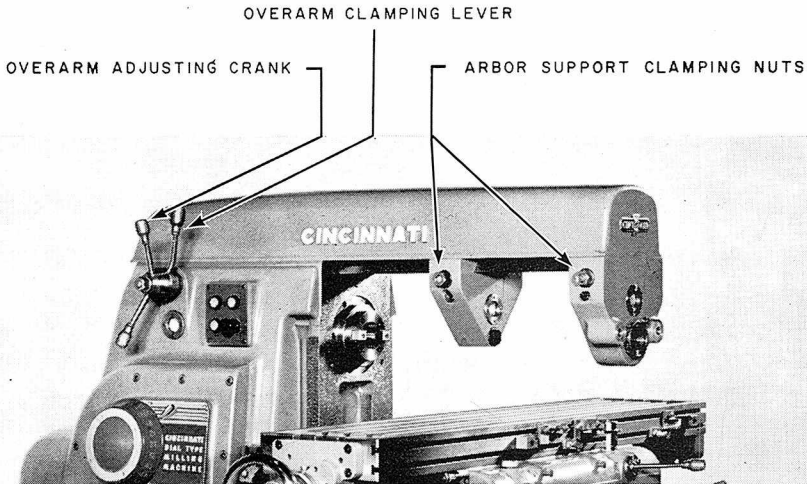


Figure 30A
Overarm and Arbor Support Clamps

The arbor supports may be positioned at any desired place on the overarm and clamped in position by tightening the clamping nuts (Figure 30A)

Reversing the Direction of Rotation of the Spindle. Spindle rotation must be the same as the "hand" of the cutter; that is, the rotation must be clockwise for a "right-hand" cutter and counter-clockwise for a "left-hand" cutter. The direction of rotation is controlled by the lever shown in Figure 30B.

Note that RIGHT and LEFT on the spindle reverse plate indicate the direction of rotation of the spindle when viewed from the rear end of the spindle.

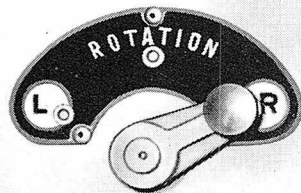


Figure 30B
Spindle Reverse Lever

SETTING UP THE MACHINE

Feed Trip Dogs. Trip dogs are provided for automatically stopping the power table, cross, or vertical feeds at the end of the cut or at any desired point in the travel of the unit. (See pages 35-40 for automatic cycle machines).

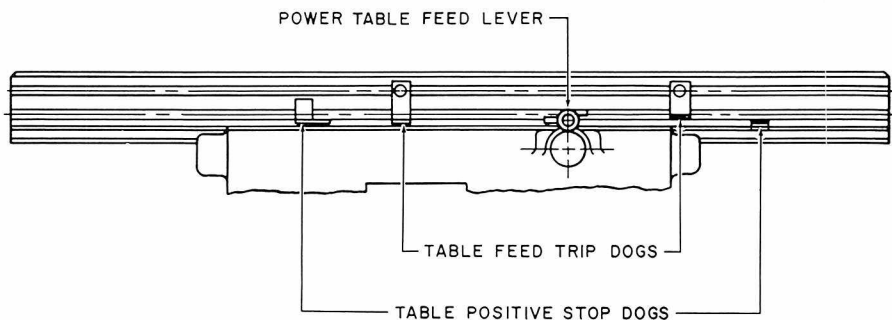


Figure 31A
Table Trip Dogs

Table Trip Dogs. Two feed trip dogs are supplied with the Dial Type Milling Machines, Figure 31A. They act only to trip the table out of feed to stop; there is no automatic reversal of direction or shift from rapid traverse to feed, or vice versa. In addition to the trip dogs, a separate pair of positive stop dogs are fastened to the front of the table to prevent moving the table beyond its actual operating range.

Caution: Do not remove these fixed stop dogs in an effort to obtain greater travel or you may seriously damage the machine. If the job requires a greater travel than the machine allows, it must be milled on a larger machine with greater range.

Knee Trip Dogs. The power vertical movements of the knee can be stopped automatically at any desired point in its travel in either direction by means of trip dogs, adjustably mounted in a tee-slot at the left-hand side of the column (Figure 32A). Two dogs are supplied, one for each direction of travel. Fixed stop pins, located in the dog rail, prevent setting the upper and lower trip dogs beyond the operating range of the machine.

Caution: Do not attempt to remove the fixed stop pins in an effort to obtain increased vertical movement or you may seriously damage the machine.

CINCINNATI DIAL TYPE MILLING MACHINES

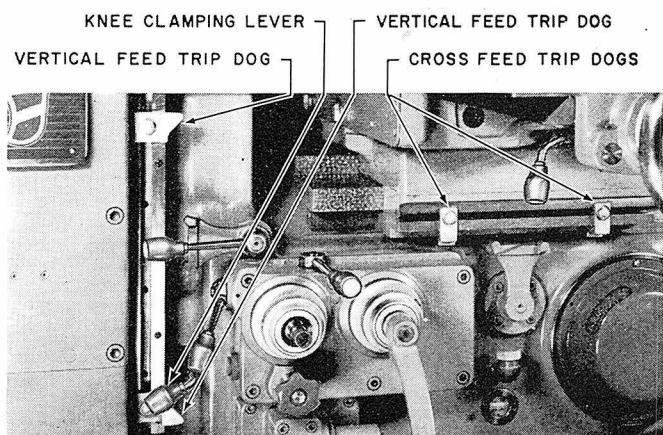


Figure 32A
Knee and Saddle Trip Dogs

Saddle Trip Dogs. The power cross feed movement of the saddle can be stopped automatically at any desired point in its travel in either direction by means of trip dogs, adjustably mounted in a tee-slot beneath the left-hand side of the saddle (Figure 32A).

In addition to the trip dogs, a separate pair of positive stop dogs are located under the dog rail. These positive stop dogs act as a safety device to prevent moving the saddle beyond its actual operating range.

Caution: Do not attempt to remove these positive stops in an effort to obtain greater cross travel or you may seriously damage the machine.

Clamping Devices for Sliding Units. The table, knee, saddle and housing may be clamped in position by tightening the screws and levers shown in Figures 32A and 33A. Two screws are provided for clamping the table to the saddle, one lever for clamping the saddle to the knee, one lever for clamping the knee to the column, and four screws (two at front of housing, Figure 34A, and two at rear) for clamping the housing to the saddle of universal machines. The sole purpose of these screws and levers is to firmly tighten the units which are not in motion during the machining operation. For example, if you are using the table feed alone, tighten the

SETTING UP THE MACHINE

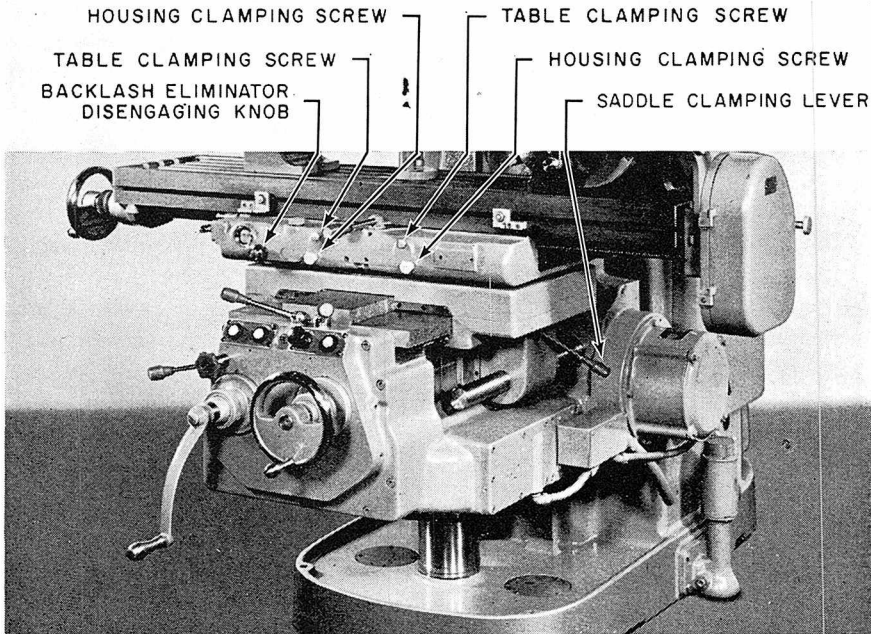


Figure 33A
Saddle and Table Clamping Devices

saddle, housing and knee clamping devices. The rigidity of the machine as a whole will thereby be increased.

These clamping devices should never be used as a method of adjustment for wear. Obviously, such a practice would result in rapid wear in the spots at which the pressure from the clamps is applied, and there is also a greater possibility of the bearings scoring, because of the concentrated pressures. Tapered gibs are provided for adjustment to compensate for wear (see "Adjusting the Gibs", page 43).

Automatic Backlash Eliminator. An integral part of the table drive mechanism is a device which *automatically* eliminates the backlash between the leadscrew and the nuts *during down-milling cuts*. The mechanism is activated by forces set up when the cutter contacts the workpiece in a down milling cut; it does not function during conventional up-milling cuts, or during rapid traverse movements of the table.

A disengaging knob is provided on the front of the saddle (Figure 33A), to permit complete disengagement when the machine is to be used for conventional milling operations only. To disengage the mechanism, turn the disengaging knob counter-clockwise as far as it will go. To re-engage, turn the disengaging knob clockwise as far as it will go.

Setting Up the Fixture and Cutters. Clamp the fixture in the center of the table, or as near the center as operating conditions will permit, to avoid as much as possible the excessive overhang of the table which causes wear on the ends of the table gib and saddle bearings. If you are using a lathe dog for holding the work, do not under any conditions use the T-slots of the table for tightening the dog screw. When these T-slots become marred, the work or fixture which is located from them will not line up properly, with the result that a new table must be purchased or the old one re-planed to obtain accurate work.

When using a cutter on an arbor, the cutter must fit accurately and the arbor must run true between dead centers to obtain the best finish on the work and freedom from chatter. The cutter must be a snug fit on the arbor for the same reason. The ends of the spacing collar and arbor nut must be perfectly clean before assembling, because dirt particles between the collars will spring the arbor when the nut is tightened. Always use as short an arbor as possible, and space the cutter as near to the spindle as operating conditions will permit.

When placing a face mill on the spindle, the best method is to place the mill on a block of wood resting on the table, and then raise the table until the face mill will slip over the spindle nose without undue exertion. Tighten each face mill screw a fraction of a turn until they are all tight.

Changing from Steel to Cast Iron Jobs. When milling a material which does not require a cutting fluid, such as cast iron, all strainers should be protected with the cover provided for them to keep fine chips and particles of metal out of the coolant system. Do not use compressed air for cleaning the machine when setting up for a new job. The chips may be blown into the bearings, resulting in untimely wear.

AUTOMATIC TABLE CYCLES

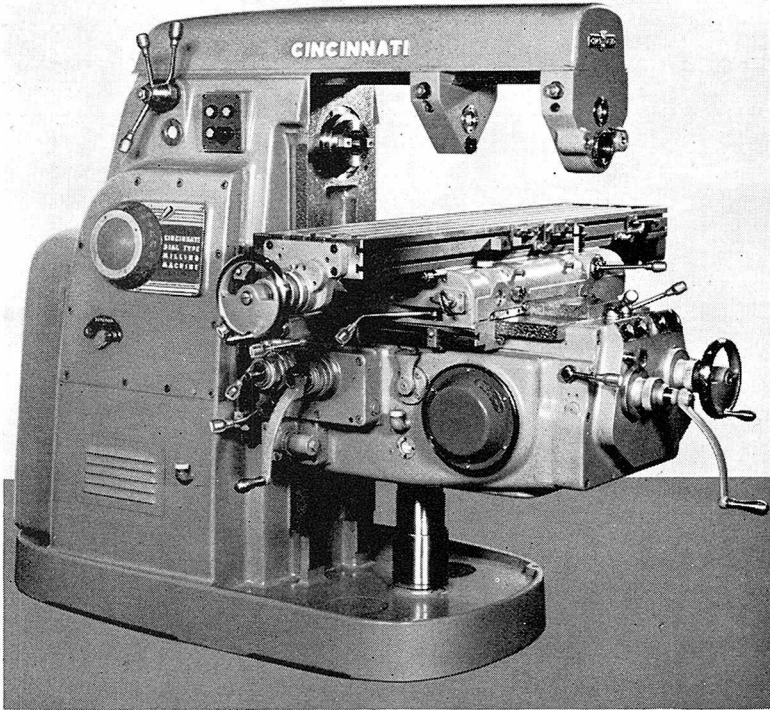


Figure 35A

Plain Dial Type Milling Machine with Automatic Table Cycles

AUTOMATIC TABLE CYCLES FOR DIAL TYPE MILLING MACHINES

Standard Dial Type Milling Machines, without Automatic Cycle, have a three-position table control lever and table dogs which act only to stop the table movement out of feed in either direction. When these machines are provided with Automatic Cycle,* a five-position table control lever is provided for hand control of table movements and table dogs act to provide completely automatic shifting from feed to rapid traverse, rapid traverse to feed, feed to rapid traverse in opposite direction, and feed to stop. Eight adjustable table control dogs are supplied with the Automatic Cycle; 2 feed dogs, 2 rapid traverse dogs, 2 reverse dogs, 1 stop dog, and 1 safety stop dog.

In addition, the extreme positions of table movement in either direction are limited by two dogs permanently pinned to the front of the table. These dogs provide a safety measure to prevent power movements of the table beyond its actual operating range.

*Note: Automatic Cycle is only available on Plain and Vertical Machines.

CINCINNATI DIAL TYPE MILLING MACHINES

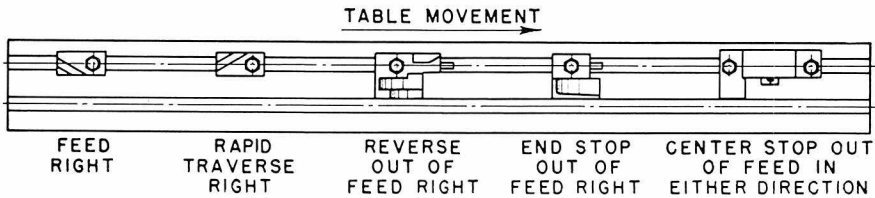


Figure 36A
Dogs Which Act with Table Moving to the Right

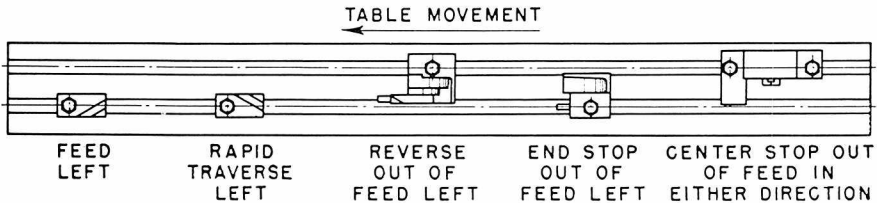


Figure 36B
Dogs Which Act with Table Moving to the Left

The feed dogs and rapid traverse dogs are of the same pattern, their function being merely to raise or lower the dog trip plunger. The upper position of the trip plunger initiates the feed rate, the lower position initiates the rapid traverse rate. Of the four dogs supplied, two are right-hand; two are left-hand. These dogs are used in the upper dog slot to control table movement to the right; in the lower dog slot to control table movements to the left Figures 36A and 36B.

The reverse dogs reverse the table from feed to rapid traverse in the opposite direction. One left-hand and one right-hand dog are supplied. Both dogs are mounted in the upper dog slot.

The center stop dog acts to stop the table from feed. It is non-directional and can be used to trip the table out of feed in either direction. When mounted in upper dog slot it stops table when feeding to the right, when mounted in lower slot it stops table when feeding to the left.

The safety stop dog also acts to stop the table from feed in either direction, but is supplied particularly to provide an automatic safety stop in the center of an automatic reciprocating cycle. It is mounted in the upper dog slot and acts to stop the table from both directions of feed.

On Automatic Cycle machines, the action of the rapid traverse control lever on the front of the knee is independent of the table control lever. When the table control lever is shifted, by hand or by the table dogs, into the rapid

AUTOMATIC TABLE CYCLES

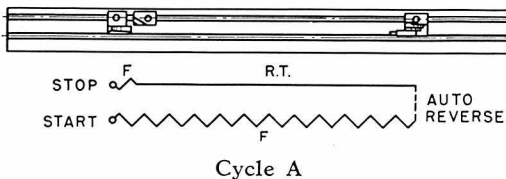
traverse position, the rapid traverse lever is not affected but remains in the neutral position. Conversely, if the table control lever is in the feed position, engaging the rapid traverse lever will put the table in rapid traverse without changing the position of the table control lever.

The cycle drawings on the following page illustrate just a few of the many useful automatic cycles which can be obtained. Cycles can progress in either direction or, as in the case of the automatic reciprocating cycle, in both directions.

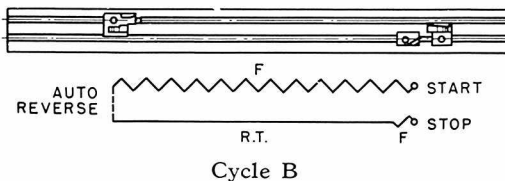
In reading the cycle drawings, they progress in the opposite direction to the actual table movement, as this illustrates the relative movement between the trip plunger and the trip dogs so that the dog can be shown directly above the cycle function it controls.

The short feed stroke at the end of some rapid traverse strokes is used to permit the table to be automatically stopped. If you have a cycle requiring more than one automatic stop, the second stop can be accomplished by using the center safety stop dog.

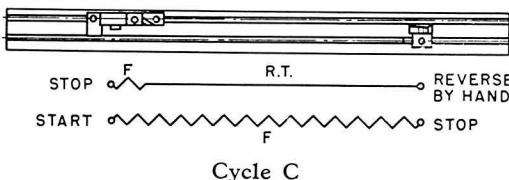
Cycles are started by shifting the table control lever to give the desired movement.



Simple milling cycle, automatic reverse and rapid return feeding left. Feed left, automatic reverse, rapid traverse right, short feed right, stop.

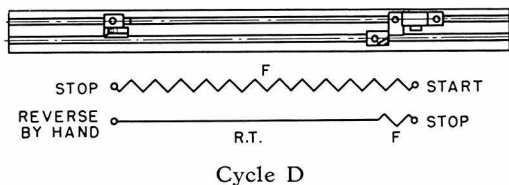


Simple milling cycle, automatic reverse and rapid return, feeding right. Feed right, automatic reverse, rapid traverse left, short feed left, stop.

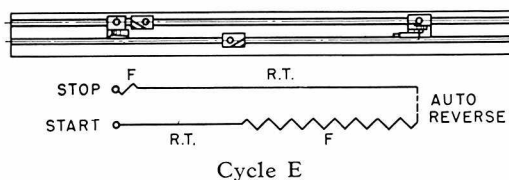


Simple milling cycle, feed to stop, hand controlled reverse and rapid return, feeding left. Feed left, automatic stop, reverse by hand, rapid traverse right, short feed right, stop.

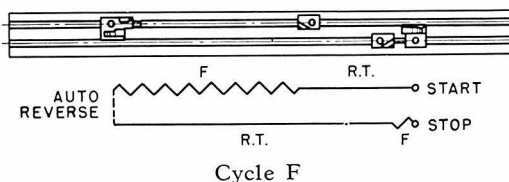
CINCINNATI DIAL TYPE MILLING MACHINES



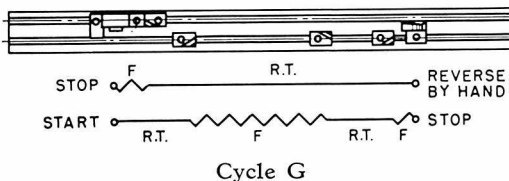
Simple milling cycle, feed to stop, hand controlled reverse and rapid return, feeding right. Feed right, automatic stop, reverse by hand, rapid traverse left, short feed left, stop.



Simple milling cycle, rapid approach, automatic reverse and rapid return, feeding left. Rapid traverse left, feed left, automatic reverse, rapid traverse right, short feed right, stop.

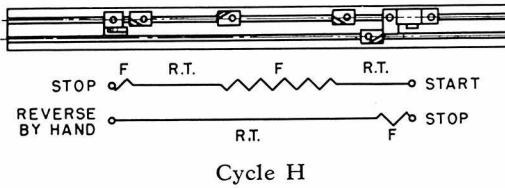


Simple milling cycle, rapid approach, automatic reverse and rapid return, feeding right. Rapid traverse right, feed right, automatic reverse, rapid traverse left, short feed left, stop.

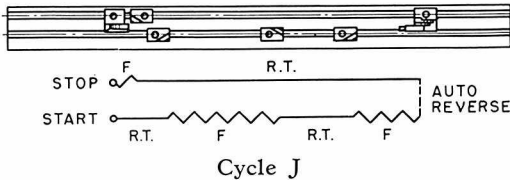


Simple milling cycle, rapid approach, rapid traverse to clear cutter, hand controlled reverse and rapid return, feeding left. Rapid traverse left, feed left, rapid traverse left, short feed left, stop, reverse by hand, rapid traverse right, short feed right, stop.

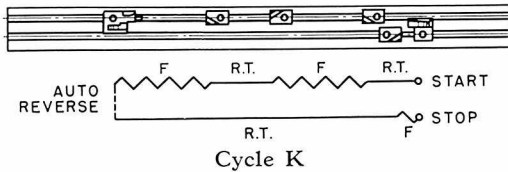
AUTOMATIC TABLE CYCLES



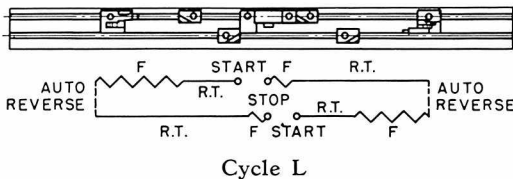
Simple milling cycle, rapid approach, rapid traverse to clear cutter, hand controlled reverse and rapid return, feeding right. Rapid traverse right, feed right, rapid traverse right, short feed right, stop, reverse by hand, rapid traverse left, short feed left, stop.



Intermittent feed cycle, rapid approach, automatic reverse and rapid return, feeding left. Rapid traverse left, feed left, rapid traverse left, feed left, automatic reverse, rapid traverse right, short feed right, stop.

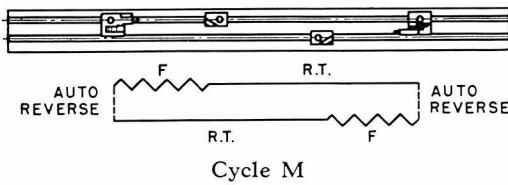


Intermittent feed cycle, rapid approach, automatic reverse and rapid return, feeding right. Rapid traverse right, feed right, rapid traverse right, feed right, automatic reverse, rapid traverse left, short feed left, stop.

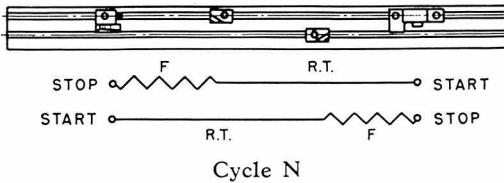


Reciprocating cycle, rapid approach, automatic reverse and rapid return, feeding both right and left, with center safety stop. Rapid traverse left, feed left, automatic reverse, rapid traverse right, short feed right, stop. Rapid traverse right, feed right, automatic reverse, rapid traverse left, short feed left, stop.

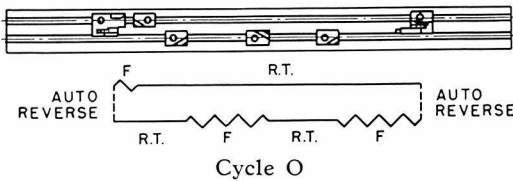
CINCINNATI DIAL TYPE MILLING MACHINES



Continuous reciprocating cycle, rapid approach, automatic reverse, feeding both right and left. Rapid traverse left, feed left, automatic reverse, rapid traverse right, feed right, automatic reverse, and repeat the foregoing steps continuously.



Reciprocating cycle, rapid approach, stop at each end, feeding both left and right. Rapid traverse left, feed left, stop, reverse by hand, rapid traverse right feed right, stop.



Continuous intermittent cycle, rapid approach, automatic reverse and rapid return, feeding left. Rapid traverse left, feed left, rapid traverse left, feed left, automatic reverse, rapid traverse right, short feed right, automatic reverse and repeat foregoing steps continuously.

RECOMMENDED CUTTING FLUIDS

RECOMMENDED CUTTING FLUIDS

CIMCOOL[®], made by the products Division of The Cincinnati Milling Machine Company is a cutting fluid resulting from a mixture of FIVE-STAR CIMCOOL Concentrate and water. FIVE-STAR CIMCOOL is recommended because of outstanding advantages, particularly in reducing heat at the tool point, freedom from rancidity, cleanliness, freedom from rust, and absence of vapors, hot chips and slippery film.

The amount of FIVE-STAR CIMCOOL Concentrate varies with the nature of the job requirements. The table below lists the starting dilutions of CIMCOOL to use when milling various materials.

RECOMMENDED CIMCOOL MIXES

Material	Average Milling Cutters	Form and Low Clearance Cutters
Mild Steel Malleable Iron Wrought Iron Bronze	FIVE-STAR CIMCOOL 1:40	FIVE-STAR CIMCOOL 1:25
Cast Iron	FIVE-STAR CIMCOOL 1:40	FIVE-STAR CIMCOOL 1:40
Brass Soft Bronze	CIMCOOL S-2 1:40	CIMCOOL S-2 1:25
Aluminum	FIVE-STAR CIMCOOL 1:40	FIVE-STAR CIMCOOL 1:25
Cast Steel Tool Steel and other high tensile strength steels	FIVE-STAR CIMCOOL 1:25	FIVE-STAR CIMCOOL 1:20

FIVE-STAR CIMCOOL may also be used with carbide tipped cutters; however, a large quantity of fluid should be supplied to insure uniform cooling and to avoid cracking the carbide tips.

GENERAL INSTRUCTIONS. Never mix FIVE-STAR CIMCOOL with other cutting fluids. Clean cutting fluid system and tank thoroughly with CIMCOOL machine cleaner before using.

Always add a pre-mixture of FIVE-STAR CIMCOOL Concentrate and water when replenishing the cutting fluid supply.

CLEANING THE CUTTING FLUID RESERVOIR AND CUTTING FLUID STRAINERS

The cutting fluid reservoir, located in the base of the machine, should be cleaned out occasionally to maintain the full capacity for cutting fluid. After pumping out the cutting fluid, remove the clean out cover on the rear of the base. With the aid of a scraper, similar to the soot scraper used on the old-fashioned coal range, scrape out the sludge. After the sludge has been removed, replace the cover. It is a good idea to coat the adjoining surfaces of the cover and base with sealing compound to prevent leakage.

Before refilling the reservoir, clean the two cutting fluid strainers in the front base (Figure 42A). Lift out the strainers and clean by washing in naphtha and then blowing them off with an air hose. Replace the strainers.

The cutting fluid reservoir should then be filled with clean cutting fluid. Approximate reservoir capacities are as follows: 15 gallons for the Nos. 210-12 and 310-12 machines, and 20 gallons for the Nos. 315-15, 415-15, 420-16 and 520-16 machines.

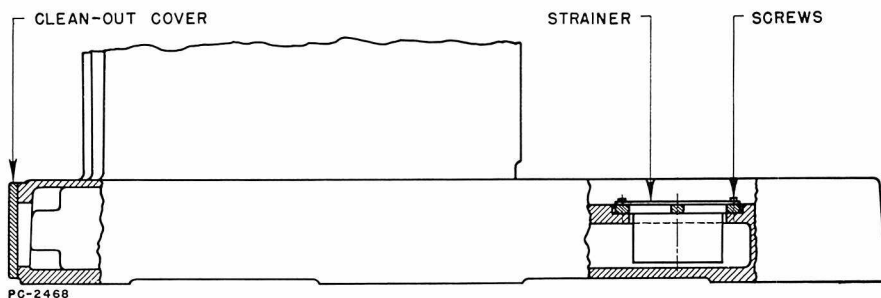


Figure 42A
Cleanout Opening and Cutting Fluid Strainers

To insure cleanliness of the reservoir and cutting fluid lines, and to avoid the conditions which lead to rancid cutting fluids, use CIMCOOL machine cleaner. It will remove both grit and dirt, and slime and oil. Use one gallon of CIMCOOL machine cleaner to 25 gallons of hot water, circulate for a half hour, and rinse with clean hot water for three minutes. Then recharge with a fresh CIMCOOL mixture.

ADJUSTMENTS

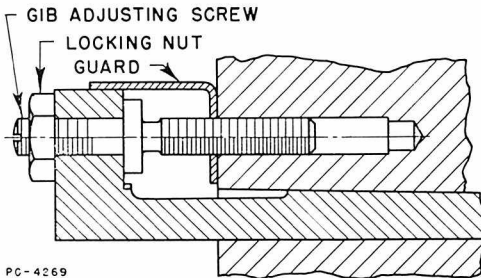


Figure 43A
Section Through Head Type Gib
with Guard

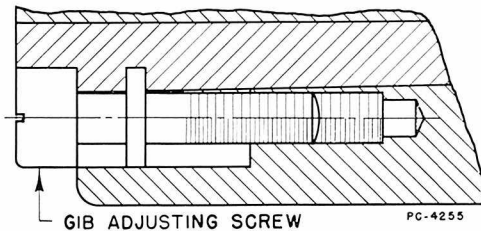


Figure 43B
Section Through Headless
Type Gib

Adjusting the Gibs. Two types of gibs, shown in Figures 43A and 43B, are used to take up the wear between the sliding units. The amount and method of adjustment, however, are about the same for each type. Adjust the gib inward (the screws have right hand threads) and try the movement of the unit with the hand crank.

When adjustment of the gibs is necessary, they should never be drawn up so tightly as to prohibit free movement of the particular unit by means of the hand crank. Tight adjustment squeezes out the oil film and causes scoring and untimely wear. Clean the bearings of the sliding units occasionally to avoid undue wear on the ends of the gibs.

Be sure to retighten the lock nut when adjusting head type gibs.

Adjusting the V-Belt Tension. If the V-belts slip due to stretch or wear, they can be tightened in the following manner:

1. Open the motor compartment door.
2. Loosen four motor mount clamping bolts (Figure 43C) and allow the motor to settle in position from its own weight.
3. Retighten the bolts and close the motor compartment door.

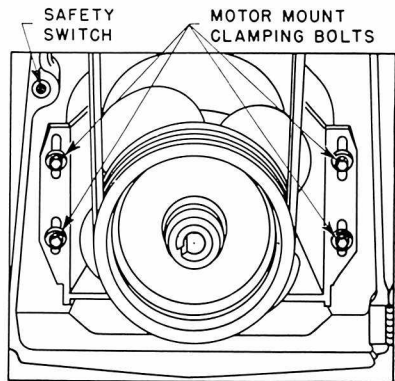
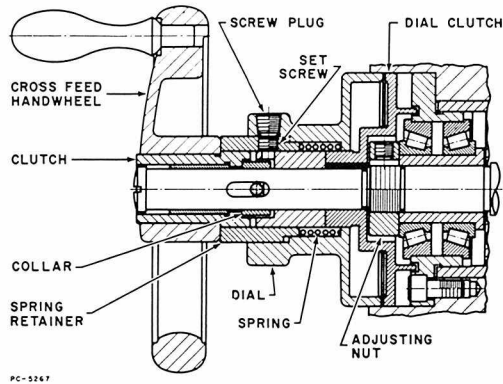


Figure 43C
Belt Tension Adjustment

Adjusting the Cross Feed Screw Bearings.

1. Remove the screw at the end of the cross feed screw, and remove the cross feed handwheel (Figure 44A).
2. Remove the screw plug through the diameter of the cross feed dial.

Figure 44A
Section Through Hand-
wheel and Front Bearing
of Cross Feed Screw



3. Turn the dial until a set screw is visible through the pipe plug hole. Remove this screw.
4. Slip the dial, spring retainer and spring off the clutch.
5. Knock out the taper pin through the clutch, remove the collar screw from the oblong slot, and remove the clutch and collar.
6. Insert eye bolts into the two threaded holes in the dial clutch, and remove it by pulling straight out.
7. The adjusting nut is now visible. However, before it can be adjusted, loosen set screw which holds adjusting nut in place.
8. With a face spanner wrench, adjust the bearing nut until tight, and then back away one slot.
9. Replace the parts in the reverse order in which they were removed.

Turn the cross feed handwheel with the power feed disengaged and try to determine by the "feel" whether the bearings have been adjusted correctly.

ADJUSTMENTS

Adjusting the Table Feed Screw Bearings. The table feed screw of these machines are provided with two sets of adjustable tapered roller bearings. When adjustment is necessary, adjust the right hand bearing only.

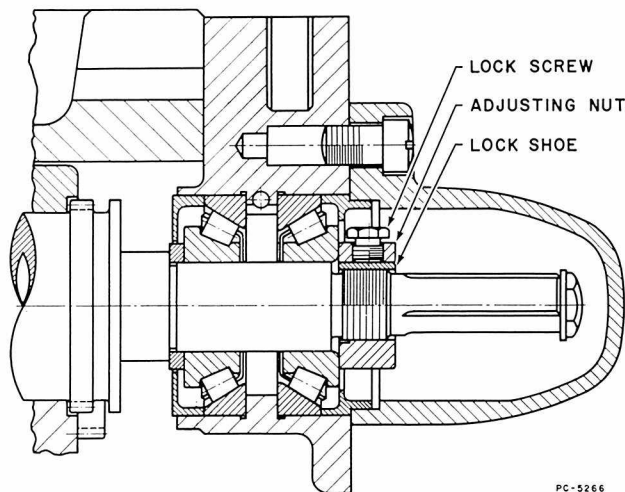


Figure 45A
Section Through Right Hand End of Table Feed
Screw Mounting

1. Remove the cone shaped cover over the end of the table feed screw at the right hand end of the table.
2. Loosen the hex head screw through the adjusting nut, and tap the screw and nut to loosen the lock shoe.
3. Tighten the adjusting nut with a face spanner wrench, and then back away about $1/16$ turn or less.
4. Re-tighten the hex head screw and replace the cover.

Turn the table traverse handwheel with the power feed disengaged and try to determine by the "feel" whether the bearings have been adjusted correctly. They should not be adjusted so tightly as to make it difficult to move the table, but on the other hand, there should not be a noticeable amount of "play" in the bearings. It is important, of course, to see that the table gib is loose enough so that the table can be easily moved in order to differentiate between a tight lead screw bearing and a tight gib bearing.

When the "play" is caused by a worn lead screw and nut, it is necessary to replace these parts in order to obtain accurate work.

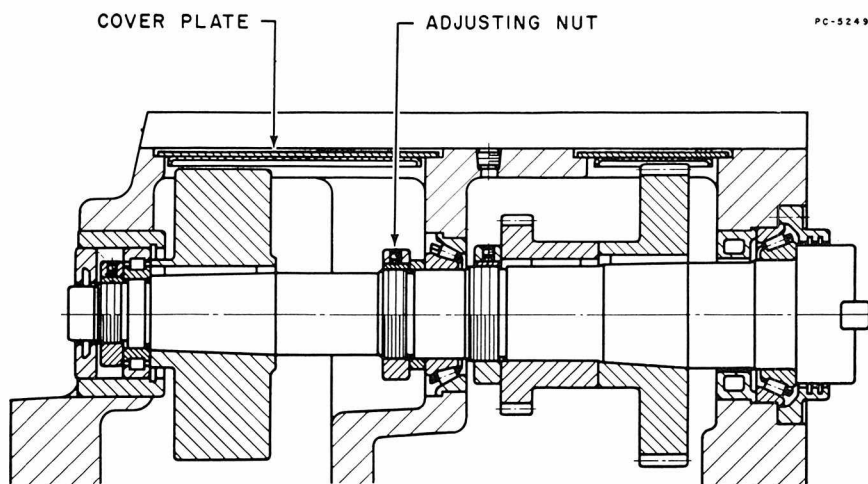


Figure 46A
Section Through Spindle of Horizontal Machine

Adjusting the Spindle Bearings.

1. Start the machine and run the spindle at a speed in the high range (above 500 rpm). Stop the spindle and set the spindle directional change lever in the center or neutral position.
2. Remove the two driving keys from the spindle nose. Clamp a rectangular rod (1" square) and about 12" long in the key slots.
3. On horizontal machines, slide overarm forward until cover plate on the back of the overarm guide ways on the column is exposed. Remove cover. On vertical machines, remove name plate from the front of vertical head.
4. Loosen the adjusting nut locking screw and tap the wrench to loosen the locking shoe beneath the screw.
5. Insert a steel bar into one of the radially drilled holes in the adjusting nut. Rotate the spindle counter-clockwise about one revolution and then clockwise until the bearings are drawn up snug.
6. Remove the bar from the adjusting nut and rotate the spindle to be sure the bearings are properly seated.

ADJUSTMENTS

7. Tighten the adjusting nut locking screw and replace the driving keys in the spindle nose.
8. Replace the cover on horizontal machines or name plate on vertical machines.

Machines which are used for general purpose work should have about .001" end play in the spindle bearings. Machines for high speed work exclusively, such as those for high speed carbide milling, should have about .002" end play in the spindle bearings. These readings are taken with the bearings cold.

This "end play" can be measured by indicating the end of the spindle nose with a $\frac{1}{10,000}$ indicator and lightly tapping the spindle from the front to the rear and reading the indicator dial. The temperature of the spindle when run continuously at its highest speed for four hours, should not exceed 145° F. when properly adjusted. Test the temperature with a thermometer inserted into one of the screw holes in the spindle cap.

Automatic Backlash Eliminator Adjustment. The mechanism is self-compensating for wear and so should not require adjustment unless dismantled. Correct adjustment can be easily checked and re-set as follows (see Figure 48A).

1. Remove the slotted screw plug from the center of the backlash eliminator disengaging knob.
2. Repeatedly engage and disengage the table power movements in either direction. Observe or indicate to the disengaging sleeve locking screw or the sleeve itself. They should move out about $\frac{1}{8}$ " to $\frac{3}{16}$ " when table power feed movement is engaged. If adjustment is necessary it can be accomplished by proceeding as follows:
3. Remove the disengaging sleeve locking screw, the disengaging sleeve, and the disengaging knob.

CINCINNATI DIAL TYPE MILLING MACHINES

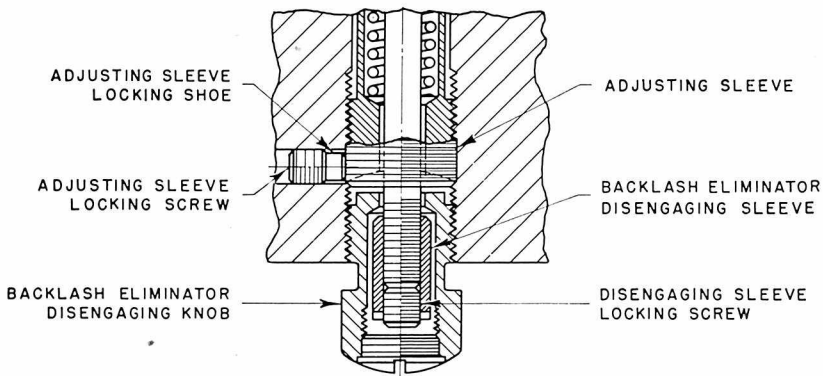


Figure 48A
Backlash Eliminator Adjustment

4. Loosen the adjusting sleeve locking screw slightly and tap the screw to loosen the locking shoe beneath. This screw is located behind the backlash eliminator disengaging knob, in the front face of the saddle, in plain and vertical machines. In universal machines this screw is behind the disengaging knob, but on the under side of the universal housing.
5. Push inward on the end of the threaded member which projects through the adjusting sleeve, and while holding it in, turn the adjusting sleeve in a clockwise direction until it seats tight against the shoulder of the rack and back it off two or three turns.
6. Retighten the adjusting sleeve locking screw.
7. Replace the backlash eliminator disengaging knob. Screw it in until it touches the adjusting sleeve and then back it off two complete turns.
8. Replace the disengaging sleeve on the threaded end of the rack. Screw it in until it touches the inner shoulder of the disengaging knob and then back it off one complete turn.
9. Hold the disengaging sleeve so it cannot turn and replace the disengaging sleeve locking screw as tightly as possible.
10. Replace the screw plug in the disengaging knob.

ADJUSTMENTS

To Adjust Hydraulic Oil Pressure in Column. This adjustment should not be required at any time, except perhaps to correct a previous mis-adjustment.

1. Start the machine and run until oil is warm, then stop machine.

2. Remove $\frac{1}{8}$ " pipe plug from selector valve line. This plug is one of six and second to the left in a horizontal line on the lower face of the shifter bracket (Figure 49A). Insert a 500 p.s.i. pressure gage in this hole.

3. Start the machine. The operating pressure should be 300 to 320 p.s.i. If too low or too high, it can be adjusted as follows:

4. Open the motor compartment door. The relief valve which controls the column oil pressure is located near the filter element on the lower right-hand side of the pulley bracket (Figure 49B).

5. Remove the slotted cap screw and the locking screw and rotate adjusting screw to correct pressure.

6. Replace locking screw and slotted cap screw. Stop machine, remove pressure gage and replace the pipe plug.

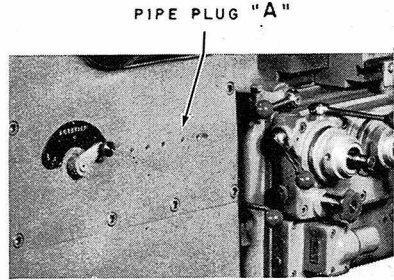


Figure 49A
Column—Side View

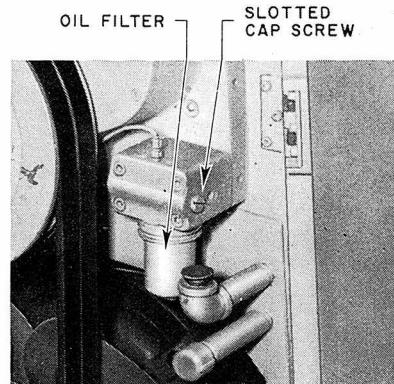


Figure 49B
Relief Valve—Column

Note—To maintain the proper cleanliness of oil in the hydraulic system, we recommend replacing the oil filter, Part No. 121486, every two months or more often if required.

To Adjust Hydraulic Oil Pressure in Knee.

1. Start machine and run until oil is warm, then stop the machine.
2. Remove the $\frac{1}{8}$ " pipe plug from the *front side* of the pump, located on the lower left side of the knee (Figure 50A), and insert a 500 p.s.i. pressure gage.
3. Start the machine. The operating pressure should be 150 p.s.i. If the pressure is too high or too low it can be adjusted as follows:
4. The relief valve which controls the oil pressure in the knee is located on the rear edge of the pump (Figure 50A).
5. Remove the slotted cap screw and the locking screw and rotate adjusting screw to correct pressure.
6. Replace the locking screw and the slotted cap screw. Stop machine, remove pressure gage and replace pipe plug.

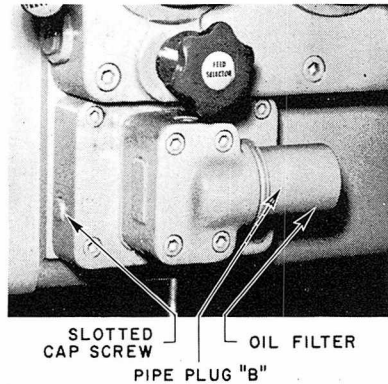


Figure 50A
Relief Valve—Knee

Note—To maintain the proper cleanliness of oil in the hydraulic system, we recommend replacing the oil filter, Part No. 121486, every two months or more often if required. (Figure 50A). At the same time the magnetic collector should be removed and wiped clean.

SAFETY PRECAUTIONS

The table, cross and vertical traverse dog slots are provided with stop dogs and screws, which limit the position for setting the trip dogs. Do not remove these stops or the trip dogs in effort to obtain more travel, as serious damage to the machine may result. If the job requires a greater range than the safety stops and dogs allow, it must be milled on a machine with greater table travel.

If the spindle speed decreases when the table starts to feed the work into the cutter, the motor is probably at fault. Have the motor inspected and repaired, if necessary, by an experienced repair man. To avoid possible damage to the clutch or motor, make these corrections as soon as you notice the spindle speed decreasing under load.

The clutches on all hand cranks are provided with releasing devices to keep them out of engagement while they are not in use. Do not remove the device for the sake of keeping the crank in engagement, as it may result in serious injury to yourself or some other operator.

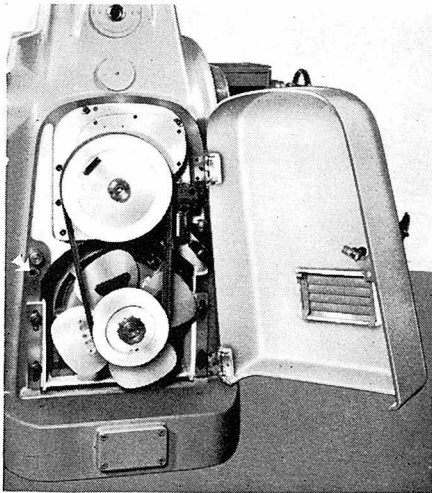


Figure 51A
Hinged Cover Open to Show Belt
Tension Adjustment and Safety Switch.

Do not try to reverse the direction of rotation of the spindle while it is in motion.

If you should decide to inspect the V-belts or the motor, and forget to shut off the electric current at the push-button station, the motor will stop as soon as the hinged cover at the rear of the machine is opened. The contact switch just below the latch bracket on the column, (indicated by arrow, Figure 51A) compensates for such an oversight by automatically breaking the circuit. When again starting the machine, it will be necessary, of course, to latch the cover and push the starting button.

DIVIDING HEAD

Cincinnati 10", 12" and 14" Dividing Heads are used extensively in milling spiral and helical gears, constant velocity drum cams, etc. The manner of transmitting motion to the spindle in the head is the same for all size heads. The Dividing Head is designed so that its spindle can be swiveled vertically. Two types of Driving Mechanisms can be used for all size heads. The table of leads shown in the rear of the book is for the Enclosed Standard Lead Driving Mechanism, supplied as standard equipment with the universal style machines.

The spindle of the dividing head is housed in a swivel block, allowing it to be swiveled to any angle from 5° below the horizontal to 5° beyond the vertical. This arrangement permits bevel gears of any pitch angle to be milled, and many other types of work requiring concentrically spaced slots or holes at an angle to the center line of the work piece.

The tailstock centers may be swiveled, and also raised or lowered, for taper work. The center-bar is reversible, to bring either the large or the small center point into working position.

Because of the splined shaft drive, the Dividing Head headstock need not be placed flush with the end of the table when set up with the driving mechanism. This is the type of set-up required for milling scrolls or certain types of cams.

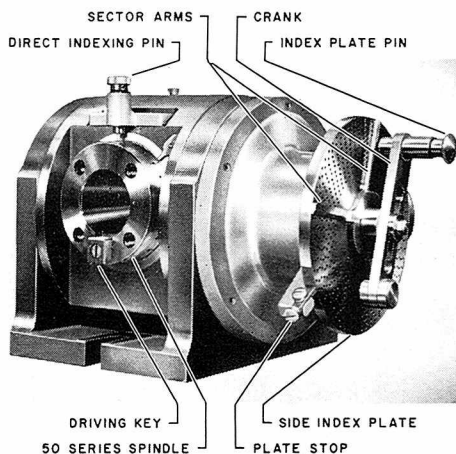


Figure 52A
Front View of Dividing Head

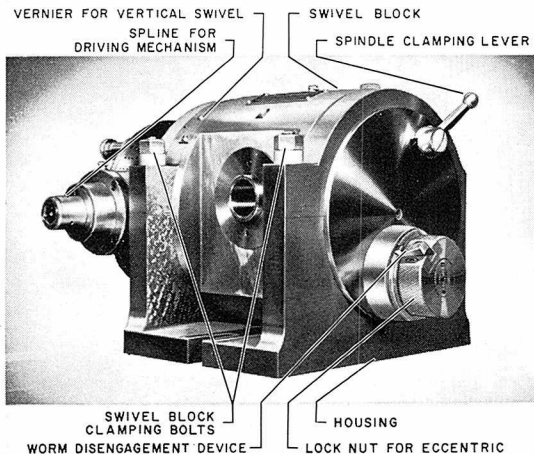


Figure 52B
Rear View of Dividing Head

DIVIDING HEAD

LUBRICATION OF 10", 12", AND 14" DIVIDING HEADS

The importance of proper lubrication cannot be over-emphasized. The continued accuracy and long life of the CINCINNATI Dividing Heads depend upon proper lubrication at all times, so do not neglect it.

Follow the instructions and specifications given below.

DIVIDING HEAD

When to Oil	Station Number	Instructions	Parts Lubricated	Specifications
Daily	1	Spring cap oilers, keep filled. Use bench oiler to fill	Front and rear bearing of mitre gear shaft.	P-55. A rust and oxidation inhibited oil. Viscosity 200-220 S.U.S. at 100° F.
Daily	2		Worm and worm-wheel, internal gearing, rear bearing of index shaft, front and rear bearing of worm shaft and spindle bearing.	
Daily	3		Bevel gearing and front bearing of index shaft.	

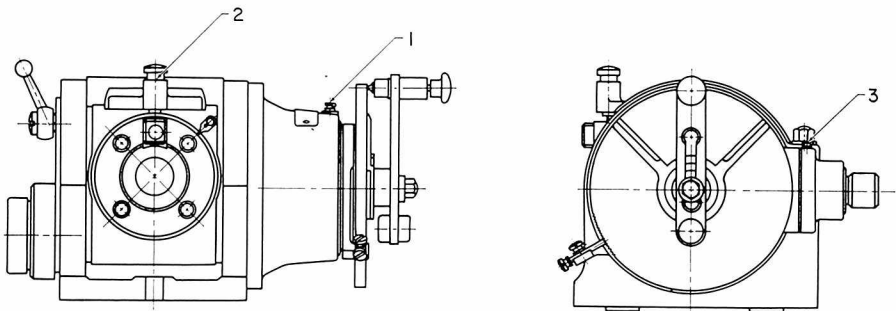


Figure 53A
Lubrication Diagram—Dividing Head

CINCINNATI DIAL TYPE MILLING MACHINES

SPECIFICATIONS FOR DIVIDING HEADS

	Size	Actual Swing	Taper Hole in Spindle	Overall Length of Tailstock	Overall Length of Head	Distance from End of Spindle to Table when Spindle is Vertical	Approx. Weight	
							Dividing Head	Tailstock
Dividing Heads . .	10"	10½"	10 B&S	6⅝"	13⅛"	10⅞"	140 lbs.	39 lbs.
	12"	12½"	11 B&S	7⅞"	15⅛"	12¼"	225 lbs.	52 lbs.
	14"	14½"	11 B&S	7⅞"	15⅛"	13¼"	233 lbs.	55 lbs.
Ratio	40 to 1							
Holes Drilled in Side Index Plate	One side—24, 25, 28, 30, 34, 37, 38, 39, 41, 42, 43 Other side—46, 47, 49, 51, 53, 54, 57, 58, 59, 62, 66							
Spindle Nose	24 hole circle							

The Sector. Index plates on all CINCINNATI Dividing Heads, have a sector for convenience in indexing. Figure 54A shows the sector set for 220 divisions, which requires that, for each division, the index pin moves over a series of twelve holes (spaces) in the 66-hole circle. The hole in which the index pointer rests, should not be counted when setting the sector. This factor is sometimes the source of a mistake in setting up dividing head work, and must not be overlooked.

After the sector is spaced for the desired number of holes and tightened with the lock screw, no further counting of holes is necessary. Merely withdraw the index pin from the hole next to the left hand arm of the sector, relocate it in the hole next to the right hand arm, and then swivel the sector to again bring the left hand arm against the pin. The Dividing Head spindle and work will then have rotated 1/220 revolution (for the set-up illustrated).

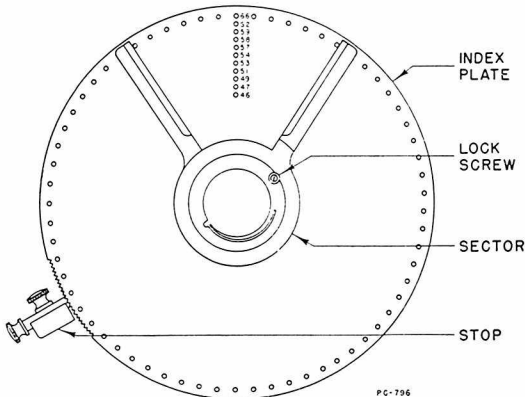


Figure 54A
Dividing Head Sector Set for 220 Divisions

Example: Suppose you want the proper setting for a 21-tooth gear. Consulting the "Index Tables" you will find that for 21 divisions you must use the 42 hole circle. Set the index plate so that the side which has the 42 hole circle faces the index pin. Set the pin in any hole in that circle and space the sector for 38 spaces. Then for each of the 21 divisions, rotate the index pin through one revolution of the crank, plus the spacing of the sector, or 38 spaces.

DIVIDING HEAD

Index Plate Stop. The index plate stop, Figure 54A, engages notches in the index plate, preventing it from rotating. If the Head is connected to the driving mechanism for a spiral or helical milling job, the index plate, sector, and crank rotate as a unit. For such a set-up, *the stop must be disengaged from the plate*. In other words, the stop should be engaged only when the Dividing Head is not connected to the power drive, as when milling spur gears, bolt heads, etc. The stop serves as a safety precaution in preventing mistakes which would occur if the index plate itself were moved slightly while indexing.

The index plate stop may also be used as a guide to accurately reset work which has been removed from the Dividing Head for purposes of inspection. First reset the work in approximate relation with the cutter. Then withdraw the index plate stop, and with the index pin engaged, rotate the crank a sufficient amount to accurately position the work. Re-engage the stop in the notches on the rim of the plate. Two inches of the circumference of the plate is notched, and the notches have a pitch of .060". Therefore, a movement of one notch on the index plate is equivalent to $\frac{1}{18460}$ of a revolution of the work.

Setting Up the Dividing Head and Driving Mechanism. The instructions outlined for this set-up should be followed in the order in which they are listed.

1. Clean the table of the milling machine and the bottom of the dividing head and tailstock.
2. Clamp the dividing head headstock in the center slot of the table, in a location suitable for the work.
3. Test the dividing head spindle with a test bar and indicator to see that it is parallel with the table.
4. Clamp the tailstock in the proper position, depending upon the length of the work.
5. Line up the tailstock center with the headstock center.
6. Line up the cutter central with the dividing head or tailstock center.
7. Lock the saddle in position.
8. Swing the table to the helix angle to be milled. (Universal machine only). If a universal milling attachment is being used on a plain machine, swing it to the helix angle to be milled.

CINCINNATI DIAL TYPE MILLING MACHINES

9. Lock the housing in position. (Universal machine only).
10. Withdraw the index plate stop (Figure 54A). The index plate must be free to revolve with the index pin. *Note*—The stop engaging the notches in the rim of the index plate should be engaged only when the Dividing Head is used without the driving mechanism.
11. Set up the change gears.
12. Set the index plate sector for the proper spacing.
13. Oil the dividing head and change gears thoroughly.

Note—With the Driving Mechanism connected to the Dividing Head, especially when the head is equipped with a Wide Range Divider (page 64) we do not recommend the use of the power rapid traverse to the table.

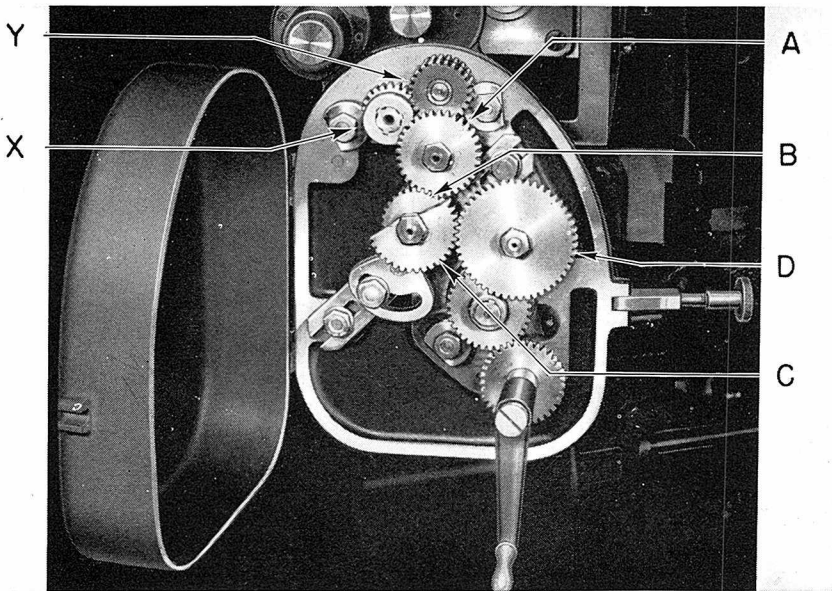


Figure 56A
Enclosed Standard Lead Driving Mechanism

How to Select the Proper Change Gears. Suppose you want to cut a helix of $15\frac{1}{4}$ " lead. Consult the "Table of Leads" and find the lead which is nearest $15\frac{1}{4}$ "—in this case 15.256". The change gears for this lead, 51, 18, 21, and 39, may be used, because the lead obtained is close enough to the lead desired for practical purposes.

You will notice that gear "C" is not listed for some leads. In such cases only one intermediate gear "B" is required, and a collar replaces gear "C".

DIVIDING HEAD

Setting Up the Change Gears. Remove the bell-shaped cover on the apron at the right-hand end of the table. It is held in position with a large slotted head screw. Then place the change gear segment on the apron, screw half-nuts on the two studs, and tighten them securely. Place the change gears in the positions indicated for the desired lead, being careful not to get gears "B" and "C" interchanged. The "hand" of the lead is fixed by gears "X" and "Y", as shown in the table below.

After the set-up has been completed, move the table by means of the hand feed crank, to be sure that the entire mechanism operates freely, before engaging the power feed. Remove the hand crank and keep the cover closed while the machine is in operation.

	Right-Hand Helix	Left-Hand Helix
Dividing Head	Remove gear Y Reverse gear X	Gears X and Y, as shown in Figure 56A

Leads Lower than Those Listed in Tables. With the enclosed standard lead driving mechanism illustrated in Figure 56A, leads lower than those listed in the tables, pages 109 to 125 can be obtained, *using hand feed only* (rotating the index crank at the side of the head). To change the gearing for low leads, remove gear "D". A 34 tooth gear is now exposed, meshing with the 34 tooth gear on the lead screw (directly below gear "D"). Remove these two 34 tooth gears, and replace them with the standard 51 tooth change gear on the lead screw and the standard 17 tooth change gear on the stud for gear "D". Instead of a 1 to 1 ratio, we now have a speed-up of 3 to 1. Leads for the change gear combinations listed are now divided by 3. However, some of the change gear combinations are not obtainable because of interference with the segment.

This set-up should be used only for occasional jobs. If leads shorter than $2\frac{1}{2}''$ are cut often, we recommend the low lead segment. With this additional equipment, the range of leads is increased to $\frac{1}{8}''$ to 100''. It should be installed at our factory. Complete instructions for this type of equipment is contained in a separate booklet "Table of Leads— $\frac{1}{8}''$ to 100'' Lead Driving Mechanism".

Leads Near the Low Range. When cutting leads with the low range of the Dividing Head driving mechanism, certain precautions must be observed. If, for example, the gears are set up for a 10" lead, the ratio of the change gears is 1 to 1, and the table feed (lead) screw rotates 40 revolutions to one revolution of the dividing head spindle.

For leads greater than 10", the dividing head spindle runs slower in relation to the speed of the lead screw. Example: 20" lead, table feed screw rotates 80 revolutions, while the dividing head spindle rotates one revolution. This requires a change gear set-up which reduces the speed from the lead screw to the dividing head, resulting in a mechanical advantage in transmitting power.

For leads shorter than 10", the dividing head spindle runs faster in relation to the speed of the lead screw. Example: 5" lead, table feed screw rotates 20 revolutions, while the dividing head spindle rotates one revolution. The change gear set-up for these low leads increase the speed from the lead screw to the dividing head, resulting in a mechanical disadvantage in transmitting power. The slow speed of the lead screw causes a "wind-up", which may produce a slightly jerky motion when milling short leads on large diameter of work. Therefore, conditions should be as nearly correct as possible when cutting short leads, particularly those from $2\frac{1}{2}$ " to 5". These conditions may be summarized in a few words. (a) the table gib should be correctly adjusted (not too tight), (b) the change gears should have a slight amount of backlash, (c) the table ways and lead screw should be well oiled, (d) the table feed screw should rotate freely. Also, it might be noted that with a relatively high table feed, say $5\frac{3}{4}$ " per minute, a greater proportion of power is available at the dividing head.

When all contributing factors are correct, the machine will pull a reasonable cut with a set-up for the lowest lead of $2\frac{1}{2}$ ". If the cut should be unnecessarily heavy, then it is advisable to feed by hand. This may be done by allowing the table feed engaging lever to remain in neutral position and driving the dividing head and table by hand through the index crank in front of the index plate. With a short lead set-up hand feed is very easy, as the mechanical advantage is then in favor of the operator.

If leads lower than 5" must be cut often, we recommend our Short and Long Lead Driving Mechanism. (It may be applied to Universal machines only). Then leads as low as .010" may be cut by power.

Rapid Traverse. When using the driving mechanism, reverse the table only when the feed is engaged. Do not reverse it while the rapid traverse is engaged, as entirely too much strain is set up in the mechanism of the machine and attachment. For example, after milling a spiral groove, reverse the table while in feed and then engage the rapid traverse to get back to the starting point.

DIVIDING HEAD

Calculating the Change Gears Required for a Given Lead. Many leads can be obtained other than those listed in the table. They were omitted because the difference was too small for ordinary requirements, but if you do not find a lead in the table which is close enough to meet your needs, the following formula will enable you to calculate all the possibilities:

$$\frac{\text{Lead}}{10} = \frac{\text{Driven}}{\text{Drivers}} = \frac{A \times C}{B \times D}$$

Suppose you want a lead of 35.789",

$$\frac{35.789}{10} = 3.5789, \quad \frac{51 \times 36}{27 \times 19} = 3.579$$

Gear A = 51 Teeth
Gear B = 27 Teeth

Gear C = 36 Teeth
Gear D = 19 Teeth

Standard change gears furnished with enclosed driving mechanism:

1 — 17 teeth	2 — 24 teeth	1 — 42 teeth
1 — 18 teeth	1 — 27 teeth	1 — 45 teeth
1 — 19 teeth	1 — 30 teeth	1 — 48 teeth
1 — 20 teeth	1 — 33 teeth	1 — 51 teeth
1 — 21 teeth	1 — 36 teeth	1 — 55 teeth
1 — 22 teeth	1 — 39 teeth	1 — 60 teeth

A few gear combinations can not be used because of interferences (and consequently are not tabulated). For example, lead 36.090, gears 48-19-30-21.

How to Calculate the Angle for Setting the Milling Machine Table or Universal Milling Attachment. Suppose you want to mill a lead of $7\frac{1}{2}"$ on a 3" diameter *work piece. The angle for swiveling the table is not shown for this combination, but it can be calculated very easily from the following formula:

$$\text{Tangent of angle} = \frac{3.1416 \times \text{diameter}}{\text{lead}}$$

$$\text{In the above example, Tan. angle} = \frac{3.1416 \times 3}{7.5} = 1.2566$$

$$\text{Angle} = 51\frac{1}{2}^{\circ} \quad (\text{See table, page 129.})$$

*Note—Use pitch diameter in calculating helix angle for helical and spiral gears, worms, etc.

How to Calculate Indexing with the Side Plate. (Standard Dividing Head). In case a particular circle of holes on the index plate becomes worn through constant use, you may be able to use some other circle of holes and get the same results.

The following set of rules and example illustrate the procedure to follow in obtaining the maximum number of settings for any condition of indexing. Since the ratio between the worm and worm-wheel in the Cincinnati Dividing Head is 40 to 1, then:

1. Divide 40 by the number of divisions required. The result gives the number of turns or fraction of a turn of the index crank.
2. If a fraction of a turn is required, the denominator (the lower part of the fraction) represents the circle to use, while the numerator represents the number of spaces in the circle over which the index pin must pass.
3. Reduce the fraction to its lowest terms, and multiply both parts of the fraction by the same number until the denominator equals the number of holes in any circle.

Example

Suppose you want to calculate all the indexing circles for 3 divisions.

$$\frac{40}{3} = 13\frac{1}{3} \text{ turns of the index crank.}$$

One-third of a turn could be obtained by rotating the index pin over one space in a 3 division circle—(Rule 2). Since we do not have a 3 hole circle, we must use one into which the number of holes can be evenly divided by 3. For instance, 8 spaces in the 24 hole circle ($8/24 = 1/3$), 10 spaces in the 30 hole circle ($10/30 = 1/3$), etc. One-third of a turn can be obtained in any of the following circles:

$$\begin{array}{l} \frac{1}{3} \times 8 = \frac{8}{24} \text{ or } 8 \text{ spaces in the 24 hole circle.} \\ \frac{1}{3} \times 10 = \frac{10}{30} \text{ " } 10 \text{ " " " } 30 \text{ " " } \\ \frac{1}{3} \times 13 = \frac{13}{39} \text{ " } 13 \text{ " " " } 39 \text{ " " } \\ \frac{1}{3} \times 14 = \frac{14}{42} \text{ " } 14 \text{ " " " } 42 \text{ " " } \\ \frac{1}{3} \times 17 = \frac{17}{51} \text{ " } 17 \text{ " " " } 51 \text{ " " } \\ \frac{1}{3} \times 18 = \frac{18}{54} \text{ " } 18 \text{ " " " } 54 \text{ " " } \\ \frac{1}{3} \times 19 = \frac{19}{57} \text{ " } 19 \text{ " " " } 57 \text{ " " } \\ \frac{1}{3} \times 22 = \frac{22}{66} \text{ " } 22 \text{ " " " } 66 \text{ " " } \end{array}$$

DIVIDING HEAD

Example

Suppose you want to calculate all the indexing circles for 56 divisions.

$$\frac{40}{56} = \frac{5}{7} \text{ of a turn of the index crank.}$$

$$\frac{5}{7} \times 4 = \frac{20}{28} \text{ or 20 spaces in the 28 hole circle.}$$

$$\frac{5}{7} \times 6 = \frac{30}{42} \text{ " 30 " " " 42 " "}$$

$$\frac{5}{7} \times 7 = \frac{35}{49} \text{ " 35 " " " 49 " "}$$

Angular Indexing. Tables for angular indexing with the standard and high number index plates are not tabulated in this book because they are little used as compared to numerical divisions. However, angular spacing can readily be calculated, keeping in mind that one complete turn of the index crank = 9° , one space in the 30 hole circle = $18'$, and one space in the 54 hole circle = $10'$. The tabulation at the right shows the angular movement of the Dividing Head spindle for a movement of the index crank of one space in the various hole circles.

Circle	One Space	Circle	One Space
24	22' 30"	46	11' 44"
25	21' 36"	47	11' 29"
28	19' 17"	49	11' 1"
30	18' 0"	51	10' 35"
34	15' 53"	53	10' 11"
37	14' 36"	54	10' 0"
38	14' 13"	57	9' 28"
39	13' 51"	58	9' 19"
41	13' 10"	59	9' 9"
42	12' 51"	62	8' 43"
43	12' 33"	66	8' 11"

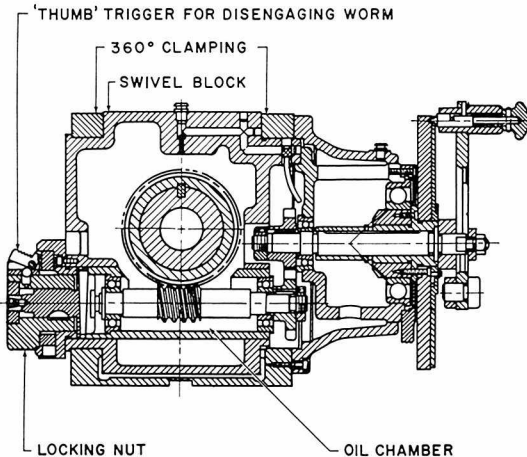


Figure 61A
Section Through Dividing Head
Showing Worm

Direct Indexing from the Spindle Nose. Direct indexing is often used for making the divisions listed in the table on page 62 because it is faster than indexing with the side plate through the 40 to 1 worm reduction. To change the dividing head into plain index centers, turn the eccentric for disengaging the worm (Figure 61A) through quarter of a turn. The worm is then disengaged and indexing is accomplished by turning the spindle by hand.

The spindle nose (Figure 62A) is drilled with a 24 hole circle. It will index any number which divides evenly into this 24 hole circle. When changing from plain indexing back to universal indexing through the side plate, it is important that the front index pin be locked in its "out" position.

Direct Indexing from the Spindle Nose

Divisions	Spaces	Divisions	Spaces
2	12	8	3
3	8	12	2
4	6	24	1
6	4		

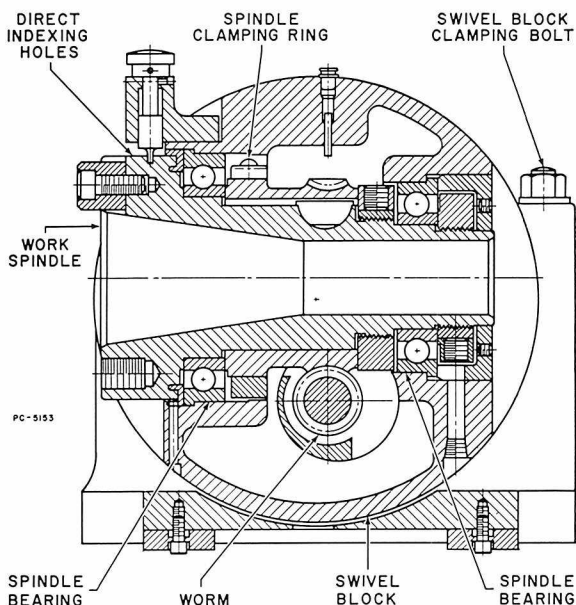


Figure 62A
Section Through Dividing Head
Showing Spindle Nose

Clamping the Dividing Head Spindle in Place.

The spindle should be clamped tightly (except when milling spirals) during heavy cutting operations to relieve all strains on the worm, worm-wheel, and index pin. Lever "A" (Figure 62B) closes 360° clamping ring "B" firmly, clamping the spindle in place. Be sure to unclamp the spindle before turning the index crank or engaging the table feed while the head is set up for milling spirals. Set screws "C" have been preset at factory and need no further attention.

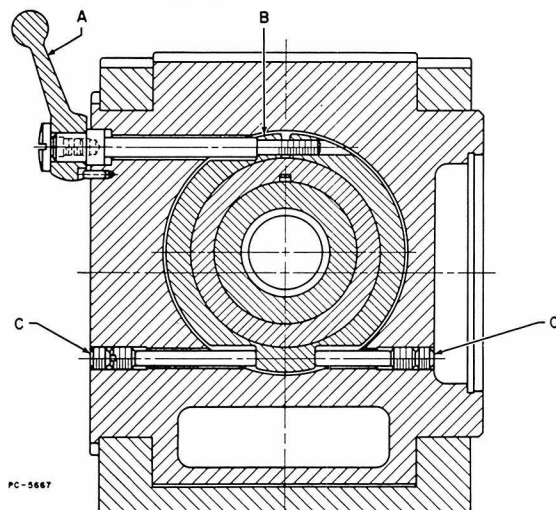


Figure 62B
Section Through Dividing Head
Showing Spindle Clamp

DIVIDING HEAD

Adjusting the Dividing Head Worm. Wear between the worm and worm-wheel may be eliminated by adjusting the two screws "A" as shown in Figure 63A. This is a critical operation and caution should be exercised when making this adjustment. To remove any backlash first engage the worm and worm-wheel as shown below. Loosen the first set screw directly under the thumb-trigger (Figure 61A) for locking the worm and worm-wheel in the engage position. Next, tighten the second set screw. *Important only loosen the first set screw a very small amount, it requires just a fraction of a turn to remove backlash.* Too much adjustment will cause excessive wear between worm and worm-wheel causing the dividing head to lose its original accuracy.

***Note**—Caution should be taken when engaging worm and worm-wheel. Do so slowly making sure worm and worm-wheel are meshing, avoiding injury to worm-wheel.

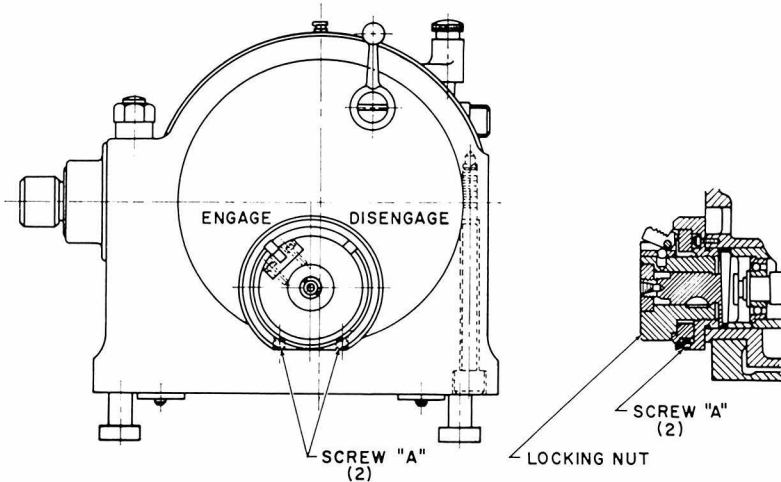


Figure 63A
Sectional View Showing Adjusting Screws for Wear
Between Worm and Worm-wheel

THE WIDE RANGE DIVIDER

The Wide Range Divider applied to a Cincinnati Universal Dividing Head enables you to obtain divisions from 2 up to 400,000. It consists of large index plate "A", sector and crank "B", together with a small index plate "C", and sector and crank "D". The mechanism is so arranged that crank "D" operates through reduction gearing of 100 to 1 ratio enclosed in housing "G". The ratio between the worm shaft and the spindle is 40 to 1.

Set up for indexing in the conventional manner. The divisions given in the table (page 104) can be obtained by utilizing crank "B" only in combination with the proper hole circle on the large plate. (Large plate drilled on both sides and contains 11 circles of holes on each side). The index pin in crank "B" can be swiveled to any hole circle. When indexing in this conventional manner, the operation is exactly the same as it is on the regular Cincinnati Dividing Heads.

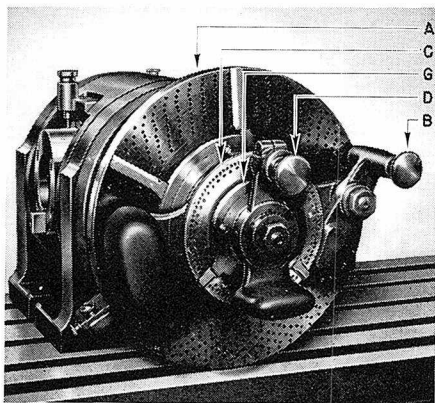


Figure 64A
Wide Range Divider

How to use the Wide Range Divider. Any whole number of divisions, up to and including 60, and hundreds of others, can be obtained with the large plate only, and the setting may be read directly from the table, page 104. If the number of divisions required is not listed in the table, calculate the setting in the following manner.

Set-up

- *1. Divide 400,000 by the number of divisions desired, for example 67.
The result gives you a whole number quotient and a fraction— $5970\frac{10}{67}$.
2. Set the sector on large index plate "A" for 59 spaces on the 100-hole circle, 59 being the first two whole numbers of the quotient obtained.
3. Set the sector on the small index plate "C" for 70 spaces on the 100-hole circle, 70 being the last two whole numbers of the quotient obtained.

***Note**—Should the quotient be a five-digit number, the first number represents the number of full turns of crank "B". (No five-digit quotient appears when making divisions higher than 40, and furthermore, calculations are unnecessary for any number less than 61).

WIDE RANGE DIVIDER

Operation

4. Index crank "B" an amount equal to the sector setting, namely—59 spaces.
5. Then index crank "D" an amount equal to the sector setting, namely—70 spaces. (Both cranks are moved in the same direction).
6. Compensate for fraction $10/67$ by adding one space to the index movement of the small crank "D" at intervals equal to the nearest whole number obtained by dividing 1 by $10/67$. The result of this division is 7. Therefore, every seventh division, index 71 spaces on the small plate "C" instead of 70. In this way one space is lost, but the resulting error is equal to only $.0000942''$ on a 12" diameter circle.

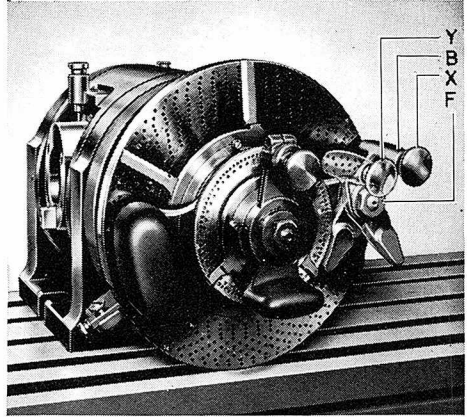


Figure 65A

When indexing in the conventional manner (divisions tabulated on page 104), index crank "B" may be changed to a different circle of holes, as from "X" to "Y", by merely loosening nut "F"

Angular Spaced Divisions.

If the divisions are spaced in degrees, minutes, and seconds, the procedure in calculating the setting is very similar to that outlined above, except that for sake of convenience, use the 54-hole circle on both plates. Complete tables are listed on pages 107 and 108.

Using crank "B" on the large plate (Figure 64A).

- (a) One complete turn is equivalent to 9 degrees.
- (b) Six spaces in the 54-hole circle equals 1 degree.
- (c) One space in the 54-hole circle equals 10 minutes.

Using crank "D" on the small plate:

- (a) One complete turn of crank "D" equals 5 minutes and 24 seconds.
- (b) Ten spaces in 54-hole circle equals 1 minute.
- (c) One space in 54-hole circle equals 6 seconds.

Example. Indexing an Angle of 3 Degree, 20 Minutes, 12 Seconds.

Set-up

1. Consulting the "Degree" table on page 107, set the sector on index plate "A" (Figure 64A) for 18 spaces on the 54-hole circle.
2. Consulting the "Fractions of a Degree" table on page 108, set sector "G" on plate "C" for 40 spaces on the 54-hole circle.

Operation

1. Index large crank "B" (Figure 64A) an amount equal to the sector setting, namely—18 spaces.
2. Index small crank "D" three turns (see table) plus the sector setting, namely—40 spaces. (Both cranks are moved in the same direction).

The index pin in the crank for the small plate is eccentric to provide a method of adjusting the pin from the 100-hole to the 54-hole circle, and vice versa. Merely loosen screw "E" (Figure 66A), rotate the pin to the desired circle of holes, and then retighten the screw.

Reversing the Large Index Plate.

(Wide Range Divider). If the set-up requires the reversal of the large index plate, the operation may be accomplished in the following manner:

1. Remove nut "A" and the washer behind it. (Figure 66A).
2. Slip differential unit "B" off the shaft.
3. Sector "C" is now free and may be removed.
4. Remove four screws "D", reverse the plate, and reassemble the parts.

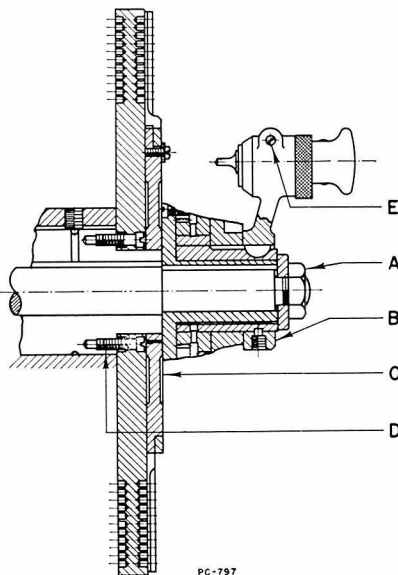


Figure 66A
Section Through Differential
Mechanism

MILLING CAMS

Rise and fall cams having a relatively narrow face may be machined by using the type of set-up indicated in Figure 67A. The cutter may be supported in any type of swiveling head, such as a Universal Milling Attachment, Independent Overhead Spindle, or a Heavy Vertical Attachment. Almost any cam lead can be machined, and by trying different machine leads, the angle to which the dividing head must be set can be changed to suit conditions. All you need in addition to this instruction book is a table of sine functions.

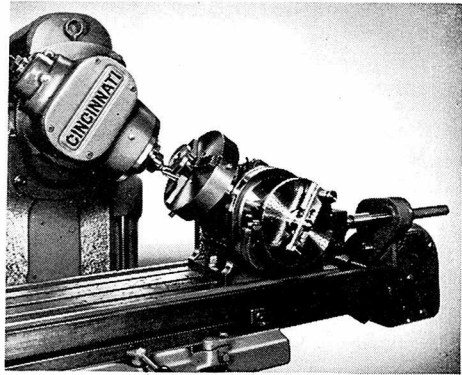


Figure 67A
Dividing Head Set Up for Milling Cams

Formula: $\frac{\text{Lead of Cam}}{\text{Lead of Table}} = \text{Sine of Angle "D"}$.

Examples:

1. Suppose you want to mill a cam having a .500" lead. Assume change gears are set up for 2.5" table lead.

$$\frac{\text{Lead of Cam}}{\text{Lead of Table}} = \frac{.5}{2.5} = .200; \text{ sine of angle "D"}.$$

"D" = 11 degrees, 33 min.

2. Suppose you want to mill a lead of 6.005".

- (a) Assume change gears are set up for 8" table lead.

$$\frac{\text{Lead of Cam}}{\text{Lead of Table}} = \frac{6.005}{8} = .7506; \text{ Angle "D"} = 48 \text{ degrees, } 39 \text{ min.}$$

- (b) Assume change gears are set up for 9.935" table lead, instead of 8", as in example 2a, then

$$\frac{6.005}{9.935} = .6044; \text{ and Angle "D"} = 37 \text{ degrees, } 11 \text{ min.}$$

ACCESSORIES AND ATTACHMENTS

HIGH NUMBER INDEX PLATES

High Number Index Plates, shown in Figure 68A, consists of three plates, drilled on both sides. These plates are interchangeable with the standard index plate on the side of the Dividing Head.

High Number Index Plates are also available for the Wide Range Divider. These are recommended only where the compensating feature is objectionable for numbers below 200.

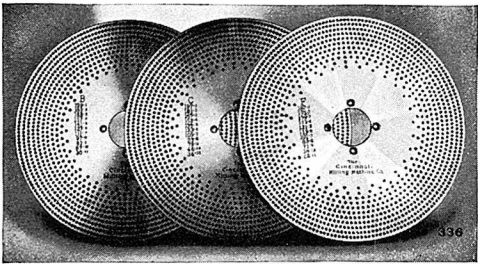


Figure 68A
High Number Index Plates

The index table shown on pages 105-106, apply to the High Number Index Plates tabulated below.

Number of Holes Drilled in Each Side of High Number Index Plates

For Standard Dividing Head					
Part No. 10525		Part No. 10526		Part No. 10527	
For Wide Range Divider					
Part No. 113505		Part No. 113506		Part No. 113507	
Side A	Side B	Side C	Side D	Side E	Side F
189	199	197	193	191	187
177	183	181	179	175	173
171	169	167	163	161	159
147	157	153	151	149	143
129	141	139	137	133	131
117	127	123	121	119	113
99	111	109	107	103	101
91	97	93	89	87	83
69	81	79	77	73	71
48	67	46	44	42	38
30	36	34	32	26	28

COMPENSATING DOG AND DRIVER

The Compensating Dog and Driver, Figure 69A, may be used with the CINCINNATI Dividing Heads. With these driving elements, greater accuracy will be obtained on taper work. The tail of the dog has a close fitting roller, which, in turn, fits into the slot of the driver. As the work is indexed, the roller slides on the tail of the dog a sufficient amount to compensate for the varying difference in the distance from the center of the work to the point of driving contact. The dog has a diameter range of $\frac{3}{4}$ " to $2\frac{3}{4}$ " for the 10", 12" and 14" Dividing Heads.

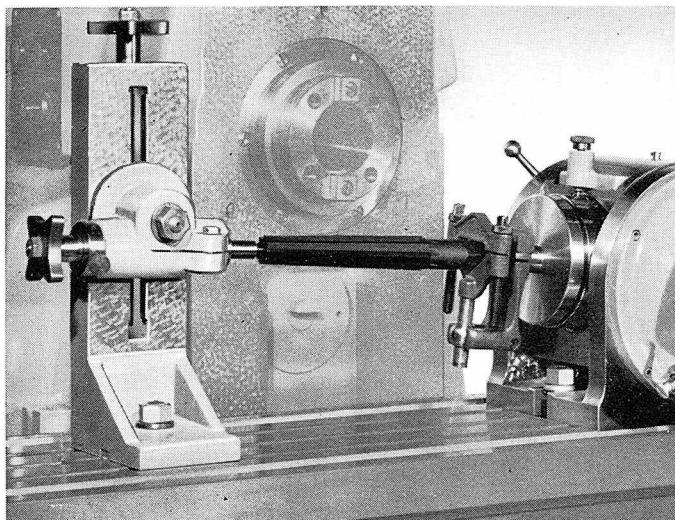


Figure 69A
High Tailstock and Compensating Dog and Driver

HIGH TAILSTOCK

If the work has a steep angle taper and is relatively long, the High Tailstock illustrated in Figure 69A may be used to advantage. The bracket carrying the center is graduated and can be set at the same angle as the work.

Maximum distance, table to center point— $11\frac{1}{32}$ ".

Minimum distance, table to center point— $3\frac{21}{32}$ ".

RAISING BLOCKS

Raising blocks, one of which is illustrated in Figure 70A, may be placed under the Dividing Head and Tailstock to obtain an increase in range. These blocks are flat, parallel, and of equal height, (supplied only in matched pairs) and give the head and tailstock a substantial support.

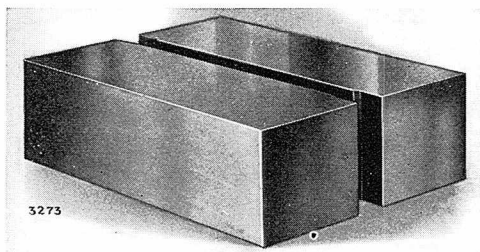


Figure 70A
Raising Block

SPECIFICATIONS

Size Head	Height of Blocks	Width T-Slots	Headstock Block		Tailstock Block	
			Length	Width	Length	Width
10"	3"	$\frac{13}{16}"$ and $\frac{11}{16}"$	$10\frac{3}{8}"$	$7\frac{7}{8}"$	$6\frac{1}{8}"$	$5\frac{1}{2}"$
12"	$2\frac{1}{2}"$	$\frac{13}{16}"$	$12\frac{7}{8}"$	$9\frac{3}{4}"$	$6\frac{1}{8}"$	$6\frac{1}{8}"$
14"	2"	$\frac{13}{16}"$	$12\frac{7}{8}"$	$9\frac{3}{4}"$	$6\frac{1}{8}"$	$6\frac{1}{8}"$

ANGLE PLATE

Angle Plates, illustrated in Figure 70B, are convenient for many types of set-ups involving a Dividing Head or small fixture placed off-center or at an angle to the table T-slots. The T-slots are standard size and at right angles to each other.

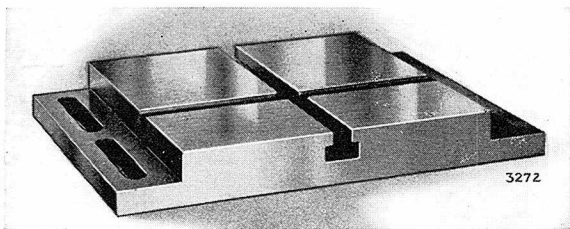


Figure 70B
Angle Plate

SPECIFICATIONS

Size Head	Height of Plate	Width T-Slot	Working Surface	Size Over All
10"	$1\frac{13}{16}"$	$\frac{11}{16}"$	$10\frac{1}{4}" \times 10\frac{3}{8}"$	$10\frac{1}{4}" \times 14\frac{1}{4}"$
12"	$2\frac{1}{8}"$	$\frac{13}{16}"$	$12\frac{3}{4}" \times 12\frac{7}{8}"$	$12\frac{3}{4}" \times 16\frac{3}{4}"$
14"	$2\frac{1}{8}"$	$\frac{13}{16}"$	$12\frac{3}{4}" \times 12\frac{7}{8}"$	$12\frac{3}{4}" \times 16\frac{3}{4}"$

ARBOR-LOC Spindle Nose Arrangement

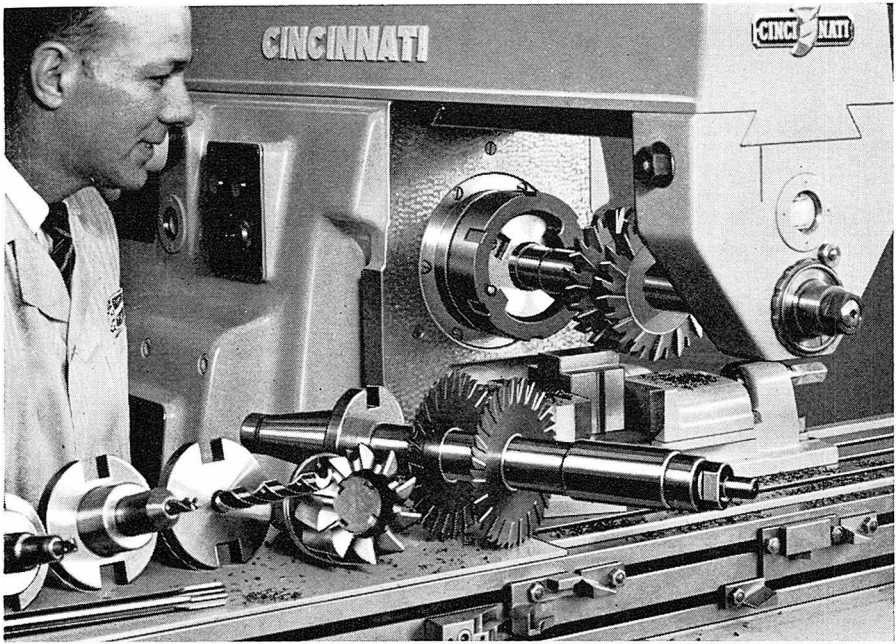


Figure 71A

A wide variety of standard long arbors and adapters may be used interchangeably with the ARBOR-LOC Spindle Nose arrangement.

The ARBOR-LOC Spindle Nose Arrangement is standard equipment on all new Dial Type Milling Machines. This unique design feature enables the operator to quickly change collets, adapters and even long arbors in seconds to perform a variety of operations on a single toolroom workpiece. (Figure 71A). To insert a cutting tool in the machine spindle nose the operator aligns the ARBOR-LOC adapter nut lugs with driving keys on the spindle nose, he then turns the adapter nut, approximately 15 degrees, to snug cutting tool in place; the cutting tool is securely held in place by using the spanner wrench (Figure 71B) supplied with the machine. The positive stop screw designed in the adapter nut is for the purpose of aligning the adapter nut lugs with driving keys on the spindle nose. This screw seats against small studs on the adapter split ring (Figure 71B) assuring accurate alignment of adapter nut lugs and driving keys of spindle nose. Complete set of ARBOR-LOC parts consists of: adapter spring, adapter split ring, adapter nut and spanner wrench. (Figure 71B)

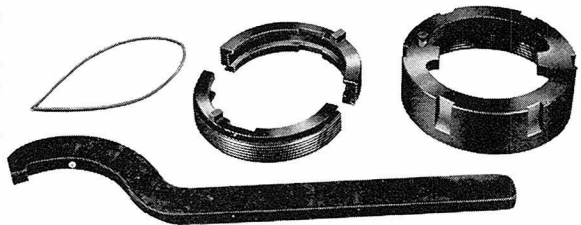


Figure 71B
Complete Set of ARBOR-LOC Parts.

Assembling ARBOR-LOC on Spindle Nose. If the ARBOR-LOC has been removed from the spindle nose for the use of some attachment or for large face milling cutters, it requires but a few minutes to reassemble. Proceed in the following manner.

1. Center the split ring (Figure 72A) on the machine spindle nose driving keys and at the same time fit them in the groove around the spindle.
2. Stretch the adapter spring (Figure 72B) around the split ring, snapping it in the groove designed in these unit parts.
3. Adapter nut is then screwed on split ring.
4. Stop screw, shown in Figure 72C, is then screwed in adapter nut. This screw has a predetermined length for the purpose of eliminating excessive turning of the nut when mounting or removing arbors and adapters. It should be screwed in until the head is seated against the co-bored hole.

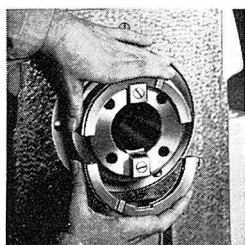


Figure 72A

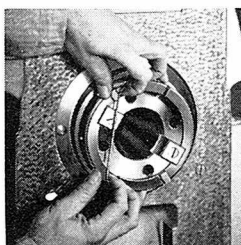


Figure 72B

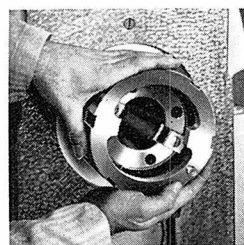


Figure 72C

ARBOR-LOC COLLET ADAPTER Reducing No. 50 to No. 40 Spindle Series

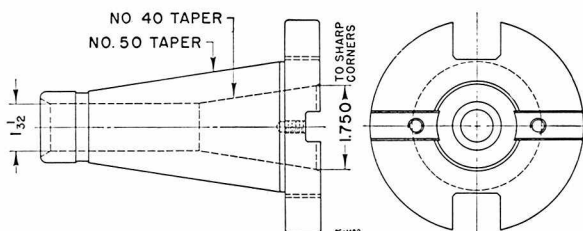


Figure 72D

Arbors and cutters having No. 40 series standard taper shanks may be used on Dial Type Millers with the above adapter.

Outside Taper.....No. 50 Milling Machine Standard
Inside Taper.....No. 40 Milling Machine Standard

ARBORS—"50" Spindle Series

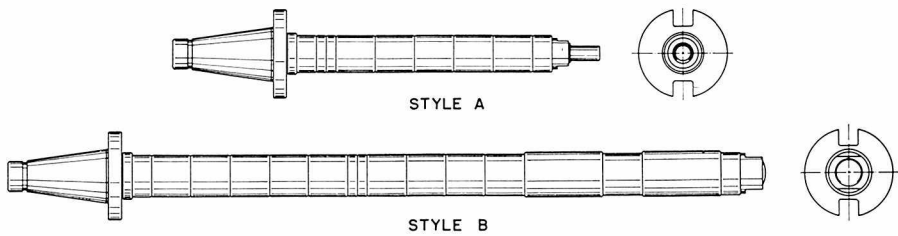


Figure 73A—Conventional Milling Machine Arbors

Catalog Number	Diameter	Style	Usable Length of Cutter Space	Diameter of Bearing Collar	Keyway		Code Name
					Width	Depth	
*50- $\frac{7}{8}$ A10	$\frac{7}{8}$	A	10	None	.....	.....	TENAR
*50-1 A12	1	A	12	None	$\frac{1}{4}$	$\frac{5}{32}$	ARTWA
*50-1 A15	1	A	15	None	$\frac{1}{4}$	$\frac{5}{32}$	ARBAA
50-1 A18-4	1	A	18	$2\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{32}$	ATARB
50-1 B18-4	1	B	18	$2\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{32}$	ARBFF
50-1 B24-4	1	B	24	$2\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{32}$	ARBFA
*50- $1\frac{1}{4}$ A12	$1\frac{1}{4}$	A	12	None	$\frac{5}{16}$	$\frac{3}{16}$	ARBCO
50- $1\frac{1}{4}$ A15	$1\frac{1}{4}$	A	15	None	$\frac{5}{16}$	$\frac{3}{16}$	AROGU
*50- $1\frac{1}{4}$ A18-4	$1\frac{1}{4}$	A	18	$2\frac{1}{8}$	$\frac{5}{16}$	$\frac{3}{16}$	ARBRU
50- $1\frac{1}{4}$ B18-4	$1\frac{1}{4}$	B	18	$2\frac{1}{8}$	$\frac{5}{16}$	$\frac{11}{64}$	BETAR
50- $1\frac{1}{4}$ B24-4	$1\frac{1}{4}$	B	24	$2\frac{1}{8}$	$\frac{5}{16}$	$\frac{3}{16}$	ONARB
50- $1\frac{1}{2}$ B18-4	$1\frac{1}{2}$	B	18	$2\frac{1}{8}$	$\frac{3}{8}$	$\frac{7}{32}$	HAFAR
50- $1\frac{1}{2}$ B24-4	$1\frac{1}{2}$	B	24	$2\frac{1}{8}$	$\frac{3}{8}$	$\frac{7}{32}$	FORAR
50- $1\frac{1}{2}$ B30-4	$1\frac{1}{2}$	B	30	$2\frac{1}{8}$	$\frac{3}{8}$	$\frac{7}{32}$	ARBTY
50- $1\frac{1}{2}$ B36-4	$1\frac{1}{2}$	B	36	$2\frac{1}{8}$	$\frac{3}{8}$	$\frac{7}{32}$	ARGOB

*Note: Arbor Support Bushing Adapter M-01 (see pages 16-17) required for "A" type arbors, numbers 50- $\frac{7}{8}$ A10, 50-1A12, 50-1A15, 50- $1\frac{1}{4}$ A12, and 50- $1\frac{1}{4}$ A15 when these arbors are to be used on machines not equipped with Style "A" arbor supports.

ARBOR-LOC SHELL END MILL ARBORS

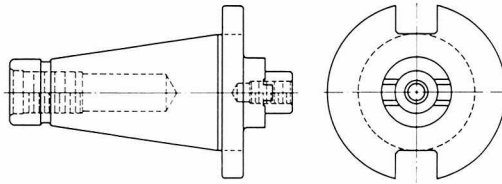
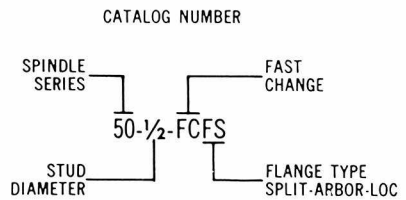


Figure 74A
Shell End Mill Arbor

Catalog No.	Diameter Range of End Mills	Stud Diam.	Code Name
50- 1/2 FCFS	1 1/4—1 1/2	1/2	YUWCS
50- 3/4 FCFS	1 3/4—2	3/4	YUWCT
50-1 FCFS	2 1/4—2 1/2—2 3/4	1	YUWCU
50-1 1/4 FCFS	3—3 1/2	1 1/4	YUWCV
50-1 1/2 FCFS	4—4 1/2—5	1 1/2	YUWCW
50-2 FCFS	5 1/2—6	2	YUWCX



Always Order Arbors by the Code Name and Catalog Number

ARBOR-LOC COLLETS (Includes Collet Draw-in Bolt)

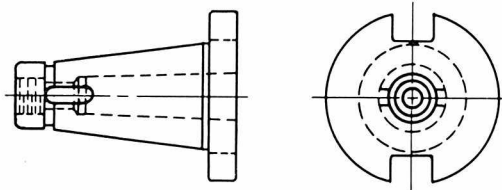
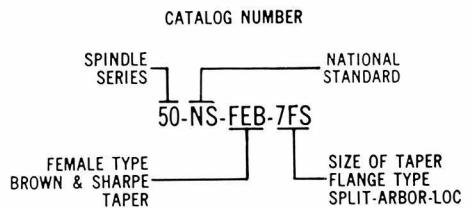


Figure 74B
Collets

Catalog No.	Inside Taper	Code Name
50NS—FEB 7FS	No. 7 B. & S.	YUWEA
50NS—FEB 9FS	No. 9 B. & S.	YUWEB
50NS—FEB 10FS	No. 10 B. & S.	YUWEC
50NS—FEB 11FS	No. 11 B. & S.	YUWED
50NS—FEM 2FS	No. 2 Morse	YUWEE
50NS—FEM 3FS	No. 3 Morse	YUWEF
50NS—FEM 4FS	No. 4 Morse	YUWEG



Always Order Arbors by the Code Name and Catalog Number

ARBOR-LOC STRAIGHT SHANK
END MILL HOLDERS

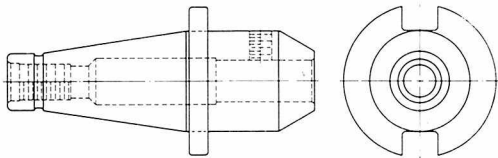
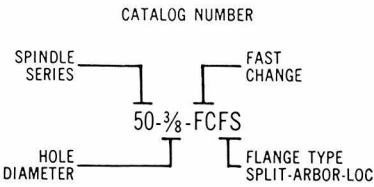


Figure 75A
Straight Shank End Mill Holders

Catalog Number	Hole Diameter (Cutter Shank)	Code Name
50W- 3/8"-FCFS	3/8"	YUWTM
50W- 1/2"-FCFS	1/2"	YUWTN
50W- 5/8"-FCFS	5/8"	YUWTO
50W- 3/4"-FCFS	3/4"	YUWTP
50W- 7/8"-FCFS	7/8"	YUWTQ
50W-1"-FCFS	1"	YUWTR
50W-1 1/4"-FCFS	1 1/4"	YUWTS



Always Order Arbors by the Code Name and Catalog Number

HOW TO STORE, HANDLE, AND USE ARBORS

The ability of a milling machine to produce accurate work in quantity or toolroom lots is dependent upon the arbor and related accessories. If the arbor is improperly stored, mis-handled, or carelessly used, both the quantity and quality of the work produced will be adversely affected. Arbors are precision tools and should be treated with much the same care as given to micrometers, vernier gages, etc. The following paragraphs deal with the proper storage, handling, and usage of arbors.

Storage. When the arbors are not in use, they should be stored in or near the milling department. There are three good methods of storing arbors in order to prevent damage or injury to them: (1) hanging vertically in a rack; (2) placed horizontally on V-supports in cabinet drawers or (3) placed vertically in a rack with the tapered end down.

The first method requires a wooden rack built to accommodate several arbors. The rack should be substantially built, strong enough to support its entire complement of arbors. Also, it should be securely anchored in place so there is no danger of the rack falling and thereby damaging the arbors. With an arbor hanging vertically and supported by its flange, even the heaviest can be easily removed by inserting an eye-bolt in the draw-in bolt hole, attaching a crane, and lifting out the arbor.

Arbor storage may also be accomplished by means of large cabinets with pull-out drawers. The drawers are of varying depths and two arbors are assigned to each drawer according to length, diameter, taper, etc. The drawer itself is so arranged as to support the arbors not only at each end of their usable length but also at the taper and flange. Each drawer should be marked with the catalog numbers of the arbors. By using this drawer arrangement, the arbors are completely protected from grit and dirt, and the possibility of injury is decreased.

Another good way to store arbors is to build a rack in which the arbor rests on its tapered end and slightly leans toward the rear. The back of the rack should support the arbor along its full length. Side rests should also be provided to prevent the arbor from falling sideways. If desired, drawers can be provided in the bottom for storing arbor collars and other accessories.

Whichever method is used, there are a few general precautions to observe when storing the arbors:

ACCESSORIES AND ATTACHMENTS

1. Wipe the arbor and its keyway clean before storing it. Then apply a light film of oil to prevent rust.
2. If the arbor collars are kept on the arbor, wipe them clean, apply oil, and assemble.
3. Gang mills on arbors should be kept in horizontal racks. Make sure supports are provided adjacent to the cutters to prevent warping.
4. Make sure the arbor is properly supported.
5. Get someone to help you lift heavy arbors to prevent injury to yourself and the arbor.

Extra arbor collars . . . back, spacing, bearing, front . . . should be stored in suitable boxes clearly marked with their name, size, etc. After the collars are used, they should be cleaned and oiled before putting them away.

Handling. Proper handling plays an important part in the long life and accuracy of the arbor. If the arbor is mishandled . . . dropped on the floor or machine table, nicked up, keyways spread apart, etc. . . . it will not perform like the precision tool which it is.

General precautions which should be observed when handling arbors are as follows:

1. Always place arbors and accessories on surfaces which will not injure them. If they must be placed on metal, protect the arbor with rags, leather, wood blocks, etc. The ideal method is to use a hardwood board fitted on each side with a V-strip to prevent the arbor from rolling.
2. If the arbor is extremely heavy, get someone to help you lift it. You may seriously injure yourself by trying to lift too heavy an arbor. Before lifting an arbor fitted with collars, tighten the arbor nut by hand to prevent pinching your fingers between sliding collars.
3. When removing an arbor from storage be careful not to let it fall. You may nick or spring it. If the arbor is dropped, or if any mishap occurs, be sure to check the arbor for run-out before using.

4. Always place a charge-out slip for the arbor you are using. Make sure you return your arbor to its proper space. When several arbors of the same size are on hand, it is a good idea to number them 1, 2, 3, etc., so that certain ones can be used for roughing while others can be used for finishing only.
5. When handling gang mills on arbors be careful of the cutters as they are sharp. If you must handle them, protect your hands with thick rags.

Usage. Proper usage has a leading role in determining the accuracy and productive capacity of the arbor. It must be remembered that the arbor is a precision tool and must be treated as such. To illustrate the correct procedure for proper usage, let's follow an arbor from the time it is received at the machine until the job is set up and running.

When the arbor is received at the machine, it may or may not be fitted with arbor collars. If it is, remove them. Then wipe the arbor and keyway clean. Be sure to protect the arbor when setting it on a metal surface.

Next, select the proper size square driving key and carefully fit it into the arbor keyway. The driving key should not fit extremely tight in the keyway because of the danger of raising burrs or damaging the keyway. For safety's sake, always drive the cutter with a key . . . never depend upon the side pressure of the arbor collars. When fitting the key, be careful not to start it crooked or you will damage the keyway thereby preventing the collars or cutters from fitting properly. File off any burrs on the key or arbor before fitting the collars.

The next step is to thoroughly clean the arbor's taper shank, flange, and the tapered hole in the spindle. These must be absolutely clean and free of even lint particles, as the smallest object will cock the arbor thereby producing inaccurate work. Then insert the tapered shank into the spindle hole, carefully fitting the spindle drive keys in the arbor key-slots. If possible have someone insert the draw-in bolt from the rear and screw it in two or three turns. Then screw it in the rest of the way and lock with the lock nut provided. It is a good idea to check the arbor for concentricity with an indicator by slowly rotating the machine spindle.

Carefully clean each individual back and spacing collar and assemble them on the arbor. The back collar is placed adjacent to the arbor flange to prevent arbor warpage or run-out. Make sure the faces of each collar

are particularly clean, as even the smallest particle will cock the collar and consequently spring the arbor when the arbor nut is drawn up tight. Of course, the cutters are also placed on the arbor. They should be mounted as close to the spindle as operating conditions will permit.

When using the Style "B" arbors, clean the bearing collar and assemble it on the arbor. Apply a light film of oil over its entire surface. Always drive the bearing collar with a key.

The next step, for both arbor styles, is to assemble the front collar and arbor nut on the end of the arbor. A front collar must be placed on the arbor before assembling the arbor nut.

Never tighten the arbor nut directly against a bearing or spacing collar as pick-up between the collar and nut will result. Tighten the arbor nut *slightly* with your hands. At no time should the arbor nut be tightened with a wrench until the arbor support is mounted over the arbor collar or pilot end.

Then mount the arbor support on the overarm and tighten its clamping nuts. Start the spindle revolving slowly and move the arbor support over the bearing collar (Style "B") or pilot end (Style "A"), as the case may be, by means of the overarm pilot wheel. Securely tighten the overarm clamping nuts and the arbor clamping nut.

A few general precautions to observe while the machine is in operation are as follows:

1. Don't rapid traverse into the cutter. You will spring the arbor and possibly break the cutter.
2. Lubricate the bearing collar thoroughly by filling the oil reservoir in each arbor support. With proper lubrication, the possibility of the bearing collar freezing and thereby twisting the arbor is eliminated.
3. Keep all parts of your body away from rotating cutters. Don't even brush chips away with a brush while the cutter is running. The coolant nozzle should be positioned so as to wash away the chips. A rotating cutter can grab the brush and severely injure your hand before you have time to jerk it away.

CINCINNATI DIAL TYPE MILLING MACHINES

4. Make sure the work is properly clamped. If the work is loosely held it will raise up and probably spring or otherwise damage the arbor.
5. Make sure all projecting parts of the fixture and work will clear the arbor, arbor support, column, etc. To check for interference, hand feed the table, fixture, and work past the stationary cutter. It should be remembered that if the projection just passes underneath the arbor, that the distance from the arbor to the work piece must be decreased by an amount equal to the depth of cut.

After the job has been completed, remove the arbor from the machine. To avoid springing, loosen the arbor nut *before* removing the arbor support. It should be carefully cleaned, the driving key removed, and then the arbor and collars should be oiled.

If gang mills are used and the cutters are not dull when the job is finished, it is a good idea not to loosen the arbor nut in order to retain the proper setting for the next running.

If the preceding recommendations for storage, handling, and usage are followed, your arbors will have a long life span and your milling machine's accuracy and productive ability will be increased.

Always Order Arbors by the Code Name and Catalog Number.

PLAIN AND SWIVEL VISES

The plain vise is illustrated in Figure 81A. With the exception of a swivel plate under the body, swivel vises are the same as plain vises. When ordering a vise, give width of T-slot in the table of the machine on which it is to be used.

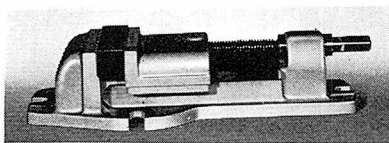
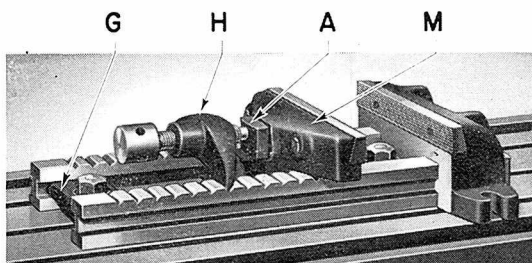


Figure 81A—Plain Vise

SPECIFICATIONS FOR PLAIN AND SWIVEL VISES

Size	Depth Jaws	Width Jaws	Jaws Open	Overall Height		Net Weight	
				Plain	Swivel	Plain	Swivel
No. 3	1 $\frac{5}{8}$ "	6 $\frac{1}{8}$ "	4"	4 $\frac{1}{4}$ "	6"	60 lbs.	80 lbs.
No. 5	2 $\frac{1}{2}$ "	8 $\frac{5}{8}$ "	7"	5 $\frac{7}{8}$ "	8"	160 lbs.	205 lbs.

ALL STEEL VISE

Figure 81B
All-Steel Vise

The CINCINNATI All-Steel Vise very effectively and conveniently holds heavy work, easily withstanding the most severe duty imposed on it by the machine. It can be set lengthwise or crosswise on the table. Screw holder "H", Figure 81B, and movable jaw "M" can be quickly set to give approximately the correct opening of the jaws. Plate "A" is hardened to withstand the pressure from the clamping screw. There are four clamping lugs on the solid jaw and one movable clamp "G". Jaw "M" can be swiveled, thus adapting it to the irregularities in rough castings or forgings. The jaws are serrated and hardened, assuring a firm grip on the work piece.

SPECIFICATIONS FOR ALL-STEEL VISE

Type	Distance from Table to Top of Vise Jaws	Net Weight	Shipping Weight	Code Word
No. 1AS	4"	80 lbs.	110 lbs.	BYVIS

TOOL MAKER'S UNIVERSAL VISE

For general tool room work. Can be swiveled in vertical plane up to and including 90 degrees—360 degrees in a horizontal plane. Maximum opening $3\frac{1}{2}$ "; depth of jaws $1\frac{5}{8}$ "; width of jaws $6\frac{1}{8}$ "; net weight 75 pounds.

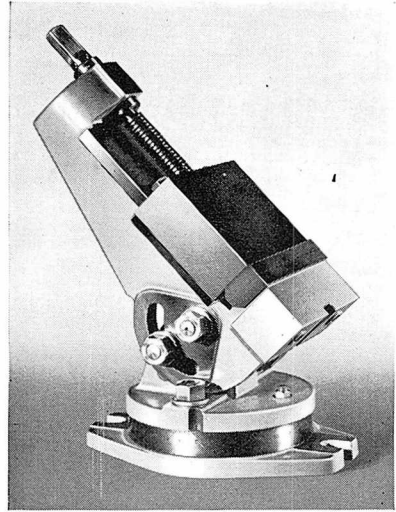


Figure 82A
Toolmaker's Universal Vise

CHUCK

Many Dividing Head jobs can be more conveniently held in a chuck than between centers. To facilitate this class of work, the 3-Jaw Universal Chuck, illustrated in Figure 82B, may be obtained.

These chucks are manufactured in three styles A, B, and C and are mounted on the Dividing Head in the following manner:

Style A threaded on an adapter which fits directly in spindle nose. Chuck size is 6" diameter for 10" dividing head. Range $\frac{1}{4}$ " to $2\frac{3}{4}$ " outside grip— $1\frac{1}{2}$ " to $3\frac{3}{4}$ " inside grip. Style B and C bolts on an adapter which fits directly in spindle nose. Style B chuck size is 6" diameter for 10" dividing head. Same range as Style A. Style C chuck size is 9" diameter for 12" and 14" dividing head. Range $\frac{1}{2}$ " to $3\frac{1}{8}$ ". Chuck, adapter and drawbolt included on all three styles.

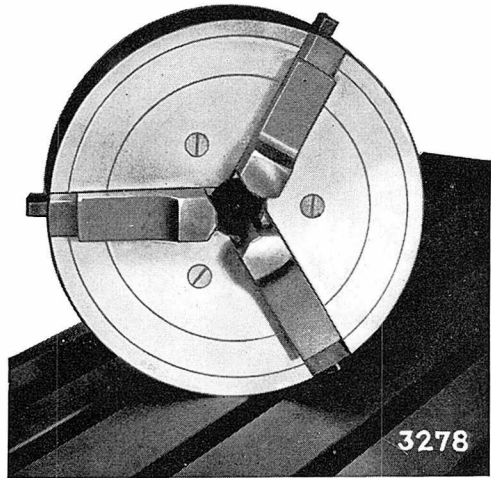
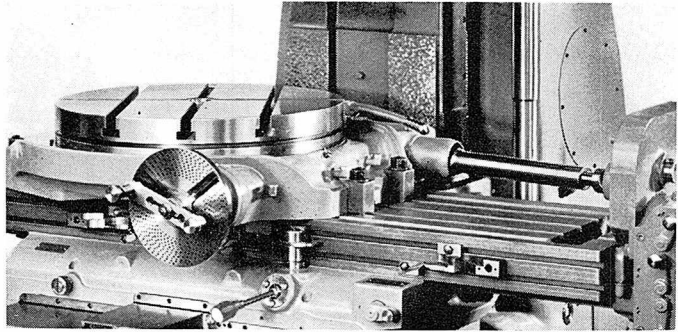


Figure 82B
Dividing Head Chuck

CIRCULAR MILLING TABLES

Figure 83A
20" Circular
Milling
Table
Arranged
for Power
Feed



Circular Milling Tables are built in four sizes, 12", 16", 20", and 24" diameter tables. The attachment shown in the illustration, Figure 83A, is a 20" size, equipped with power feed. Hand feed attachments are essentially the same except that the driving bracket at the right-hand end of the milling machine table is not supplied.

To set up the Circular Milling Table with power feed mechanism, proceed in the following manner:

1. Clean the milling machine table and the bottom of the circular milling table base.
2. Mount the unit in the center slot of the table about midway between the ends.
3. Remove the bell-shaped cover at the right-hand end of the table.
4. Remove the hexagon head screw from the end of the spline shaft bearing in the power driving bracket. (Also remove the spline shaft if it has been left in the driving bracket from previous use).
5. Assemble the driving bracket to the right-hand end of the table with the screws provided, and at the same time slip the driving sleeve from the bracket over the fork shaft from the circular table (or vice-versa if the shaft and sleeve are reversed).
6. Insert the splined shaft in its bearing and push it through until the shoulder rests against the end of the bearing. The other end of the shaft is then engaged in the driving gear. Try by hand to see that it turns without binding.
7. Replace the hexagon head screw in the end of the spline shaft bearing to keep the spline shaft in position.
8. The unit is now ready to use, either with hand feed or power feed rotary motion. For conventional circular milling, the machine feed levers must be in neutral position and the machine table should be locked in position with the table clamping screws provided for this purpose. For milling scrolls or cams, disregard these two requirements.

Starting and stopping the circular table should always be performed by means of the lever at the rear of the attachment housing.

To obtain *power rapid traverse* to the circular table, engage the conventional machine rapid traverse lever and then engage the unit starting lever.

The actual feed rate obtained with the circular table depends upon two factors, one, diameter of work and two, table feed setting. For example, if the machine feed dial indicates $3\frac{1}{2}$ " per minute, you probably will not be obtaining this feed rate on the work unless the diameter happens to be exactly right.

The tables on pages 87 to 90 list the actual feeds obtained, corresponding to the indicated feed and the diameter of the work to be milled. The tables should be used in this manner—Suppose you have a 20" table on the machine with an 8" diameter work piece, and you desire to use a feed of about $4\frac{1}{2}$ " per minute. Under 8" diameter follow down the 20" column until you come to 4.40 and then follow to the left and you will see that you should set the table feed for $3\frac{1}{4}$ " per minute.

Adjustments for the 12" Circular Table. Cincinnati Circular Milling Tables are provided with means of adjustment for wear between the worm and the worm-wheel and between the circular table and housing.

If these adjustments are necessary on the 12" size, both adjustments can be made at the same time, proceed as follows: (Hand Feed Tables Only.)

1. Loosen locking shoe set screw in locking nut "A". (Figure 84A).
2. Tap nut lightly to break contact between shoe and nut.
3. Loosen nut "A" $\frac{1}{4}$ of a turn.
4. Remove six clamping screws "B" (Figure 84A).
5. Remove clamping ring "C."
6. Turn the eccentric bushing "D" (Figure 84A) until there is no play between the worm and worm-wheel. (Stud "E" and the worm-wheel are bolted to circular table and move as a unit in a straight line when the eccentric bushing "D" is turned.)

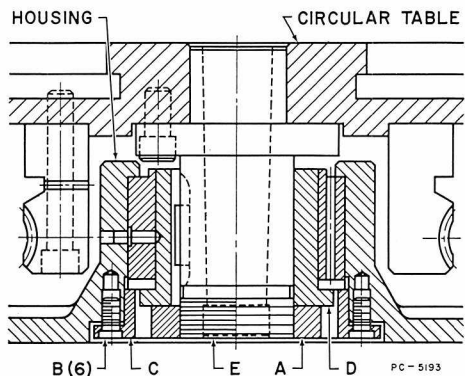


Figure 84A
Section Through Eccentric

7. Replace clamping ring "C" and fasten in place.
8. Tighten nut "A" adjusting play between circular table and housing.
9. Tighten locking shoe set screw.

Do not make these adjustments so tight as to prohibit free movement of the circular table with the hand crank.

Adjustments for 16" Tables. To adjust for wear between the worm and worm-wheel of the 16" unit proceed as follows:

1. Loosen screw "B" (Figure 85A).
2. Move lever "A" to the left beyond the upper pin hole, fully engaging the worm with the worm-wheel.
3. Tighten screw "B".
4. Loosen screw "C" and turn lever "A" to the right until the pin falls into the upper hole.
5. Retighten screw "C".

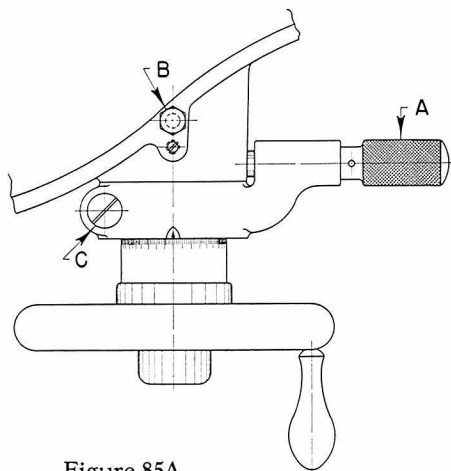


Figure 85A
Worm Adjustment for
16" Table

Do not make the adjustment so tight as to prohibit free movement of the circular table by means of the hand-wheel.

Circular gibs are provided to take up the wear between the circular table and housing. To make this adjustment proceed as follows:

1. Remove the four set screws "A" from the bottom of the housing. (Figure 85B).
2. Tighten each gib adjusting screw "B" the same amount until there is no play in the table. Try table rotation by hand after each screw adjustment.
3. Replace set screws "A". Try table rotation by hand. It must rotate smoothly.

The two $\frac{1}{2}$ " hexagon nuts located between the four set screws are for clamping the table in position.

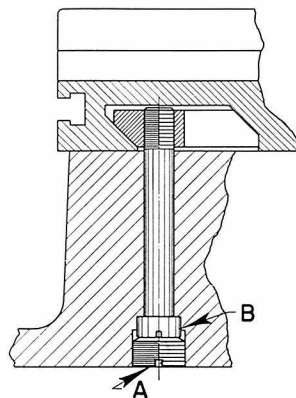


Figure 85B
Gib Adjustment for
16" Table

The driving worm of the 16" table may be entirely disengaged from the worm wheel by moving lever "A" (Figure 85A) to the right until the pin falls into the lower pin hole. The table is then free to revolve independently of the worm.

Adjustment for the 20" and 24" Tables. Cincinnati Circular Milling Tables are provided with means of adjustment for wear between the worm and worm-wheel.

If this adjustment is necessary on the 20" and 24" sizes, proceed as follows:

1. Remove the hand crank and micrometer dial.
2. Take up the end play of the worm by tightening the adjusting nut. (The worm of the 20" and 24" tables is provided with ball thrust bearings for absorbing the end thrust when making heavy cuts with power feed.)
3. Replace the micrometer dial and hand crank.
4. Loosen the two hex head screws "A-A" from the bottom of the housing. (Figure 86A).
5. Turn the eccentric bushing "B" until there is no play between the worm and worm-wheel. (The sleeve "C" and the worm-wheel are bolted to the circular table and move as a unit in a straight line when the eccentric bushing "B" is turned.)
6. Retighten screws "A-A".

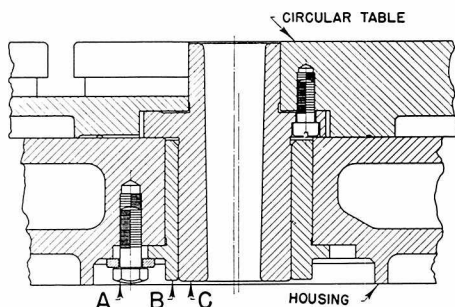


Figure 86A
Section Through Eccentric
Adjusting Bushing

Do not make the adjustment so tight as to prohibit free movement of the circular table with the hand crank

FEEDS OBTAINED ON CIRCULAR MILLING TABLES CORRESPONDING TO
DIAMETER OF WORK AND INDICATED FEED—FOR $\frac{1}{4}$ "-60" PER MIN. FEED RANGE

Dia. Work→	1"		2"		3"		4"		5"		6"		7"		8"		9"	
	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"
I	.028	.042	.057	.084	.078	.126	.113	.168	.142	.210	.170	.253	.199	.295	.227	.337	.255	.379
N	.035	.053	.071	.106	.106	.158	.142	.221	.177	.263	.213	.316	.248	.368	.284	.422	.319	.474
I	.043	.063	.085	.127	.128	.190	.170	.253	.212	.316	.256	.379	.298	.442	.341	.506	.383	.568
C	.050	.074	.099	.148	.149	.221	.198	.295	.248	.368	.298	.443	.348	.516	.398	.590	.447	.665
I	.057	.084	.114	.169	.170	.253	.227	.337	.284	.421	.340	.506	.397	.590	.454	.675	.510	.758
C	.071	.105	.142	.211	.213	.316	.284	.421	.354	.526	.426	.632	.497	.737	.568	.843	.638	.948
A	.085	.126	.170	.253	.256	.379	.340	.505	.425	.632	.511	.759	.596	.884	.682	1.02	.766	1.14
I	.099	.148	.199	.296	.298	.442	.397	.590	.496	.737	.596	.885	.695	1.06	.795	1.18	.894	1.33
E	.122	.179	.242	.358	.362	.537	.482	.716	.603	.895	.725	1.07	.845	1.25	.967	1.43	1.08	1.61
D	.142	.211	.284	.422	.426	.633	.568	.843	.709	1.05	.852	1.26	.993	1.47	1.14	1.69	1.27	1.90
C	.170	.253	.340	.506	.511	.759	.681	1.01	.851	1.26	1.02	1.52	1.19	1.77	1.36	2.02	1.53	2.28
M	.199	.295	.397	.590	.596	.885	.795	1.18	.993	1.48	1.19	1.77	1.39	2.06	1.59	2.36	1.79	2.68
A	.241	.358	.482	.717	.724	1.07	.965	1.43	1.21	1.79	1.45	2.15	1.69	2.51	1.93	2.87	2.17	3.22
C	.284	.421	.568	.843	.852	1.27	1.13	1.69	1.42	2.11	1.70	2.53	1.99	2.95	2.27	3.37	2.55	3.79
H	.340	.505	.680	1.01	1.02	1.52	1.36	2.02	1.70	2.53	2.04	3.03	2.38	3.54	2.73	4.04	3.06	4.55
I	.397	.590	.795	1.18	1.19	1.77	1.59	2.36	1.98	2.94	2.38	3.54	2.78	4.13	3.18	4.72	3.58	5.31
L	.482	.716	.965	1.43	1.45	2.15	2.04	2.86	2.41	3.58	2.90	4.30	3.38	5.01	3.86	5.73	4.33	6.45
E	.567	.843	1.14	1.69	1.70	2.53	2.27	3.37	2.84	4.21	3.40	5.06	3.97	5.90	4.54	6.74	5.10	7.58
N	.709	1.05	1.42	2.11	2.13	3.16	2.84	4.21	3.54	5.26	4.26	6.32	4.97	7.37	5.68	8.43	6.38	9.48
E	.851	1.26	1.70	2.53	2.56	3.79	3.40	5.05	4.25	6.31	5.11	7.59	5.96	8.85	6.81	10.2	7.66	11.4
8 3/4	.993	1.48	1.99	2.96	2.98	4.42	3.97	5.90	4.96	7.36	5.96	8.85	6.95	10.6	7.95	11.8	8.94	13.3
10	1.13	1.68	2.26	3.36	3.40	5.06	4.54	6.74	5.67	8.43	6.81	10.1	7.94	11.8	9.09	13.5	10.2	15.2
12	1.36	2.02	2.73	4.04	4.08	6.07	5.45	8.09	6.81	10.1	8.18	12.1	9.54	14.2	10.9	16.2	12.3	18.2
14 1/2	1.65	2.44	3.29	4.89	4.94	7.33	6.58	9.78	8.23	12.2	9.88	14.7	11.5	17.1	13.2	19.6	14.8	22.0
18	2.04	3.03	4.08	6.07	6.13	9.10	8.17	12.1	10.2	15.2	12.3	18.2	14.3	21.2	16.4	24.3	18.4	27.3
21 1/2	2.44	3.62	4.88	7.25	7.33	10.9	9.76	14.5	12.2	18.1	14.6	21.8	17.1	25.4	19.6	29.0	21.9	32.6
26	2.95	4.38	5.90	8.77	8.85	13.2	11.8	17.5	14.7	21.9	17.7	26.3	20.6	30.6	23.6	35.1	26.6	39.4
31	3.52	5.22	7.04	10.4	10.6	15.7	14.1	20.9	17.6	26.1	21.1	31.4	24.6	36.6	28.2	41.8	31.6	47.0
36	4.08	6.07	8.17	12.1	12.3	18.2	16.3	24.2	20.4	30.3	24.5	36.4	28.6	42.4	32.7	48.5	36.8	54.6
42	4.77	7.07	9.53	14.2	14.3	21.2	19.1	28.3	23.8	35.4	28.6	42.5	33.4	49.5	38.2	56.6	42.8	63.7
50	5.67	8.43	11.4	16.9	17.0	25.3	22.7	33.7	28.3	42.1	34.0	50.6	39.7	59.0	45.4	67.5	51.1	75.8
60	6.81	10.1	13.6	20.2	20.4	30.3	27.2	40.4	34.0	50.5	40.8	60.7	47.7	70.7	54.5	80.9	61.2	91.0

FEEDS OBTAINED ON CIRCULAR MILLING TABLES CORRESPONDING TO
DIAMETER OF WORK AND INDICATED FEED—FOR $\frac{1}{4}$ "-60" PER MIN. FEED RANGE

Dia. Work→ Size *Table→	10"		11"		12"		13"		14"		15"		16"		17"	18"	19"	20"
	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	20" and 24" and 24"	20" and 24" and 24"	20" and 24" and 24"	20" and 24" and 24"
I $\frac{1}{4}$	.284	.421	.312	.463	.341	.506	.369	.548	.397	.590	.426	.632	.454	.674	.716	.758	.800	.842
N $\frac{5}{16}$	.355	.527	.391	.580	.426	.632	.461	.685	.497	.737	.533	.791	.567	.843	.895	.948	1.00	1.05
D $\frac{3}{8}$	.425	.632	.468	.695	.511	.758	.553	.821	.596	.885	.648	.948	.680	1.01	1.07	1.14	1.20	1.26
I $\frac{7}{8}$	.597	.736	.546	.811	.596	.885	.645	.958	.695	1.06	.745	1.11	.795	1.18	1.25	1.33	1.40	1.47
I $\frac{1}{2}$	.843	.926	.624	.926	.681	1.02	.738	1.10	.794	1.18	.852	1.26	.908	1.35	1.43	1.52	1.60	1.68
C $\frac{5}{8}$	.709	1.05	.781	1.16	.852	1.27	.923	1.37	.993	1.48	1.06	1.58	1.14	1.69	1.79	1.90	2.00	2.10
A $\frac{3}{4}$	.851	1.26	.936	1.39	1.04	1.52	1.11	1.64	1.19	1.77	1.28	1.90	1.36	2.02	2.15	2.27	2.40	2.52
T $\frac{7}{8}$	.993	1.48	1.09	1.62	1.19	1.77	1.29	1.92	1.39	2.06	1.49	2.22	1.59	2.36	2.51	2.65	2.80	2.95
E $\frac{1}{16}$	1.21	1.79	1.33	1.97	1.45	2.15	1.57	2.33	1.69	2.51	1.81	2.69	1.93	2.87	3.05	3.22	3.40	3.58
D $\frac{1}{8}$	1.42	2.11	1.56	2.32	1.70	2.53	1.84	2.74	1.99	2.95	2.13	3.16	2.27	3.37	3.58	3.79	4.00	4.22
A $\frac{1}{4}$	1.70	2.53	1.87	2.78	2.04	3.04	2.22	3.28	2.38	3.54	2.56	3.79	2.72	4.04	4.30	4.55	4.80	5.06
T $\frac{1}{2}$	1.99	2.95	2.18	3.24	2.38	3.54	2.58	3.83	2.78	4.13	2.98	4.43	3.18	4.72	5.01	5.31	5.60	5.90
M $\frac{3}{8}$	2.42	3.58	2.66	3.94	2.90	4.30	3.13	4.66	3.38	5.02	3.62	5.37	3.86	5.73	6.08	6.45	6.80	7.17
A $\frac{1}{2}$	2.84	4.22	3.12	4.63	3.40	5.06	3.69	5.47	3.97	5.90	4.26	6.32	4.54	6.74	7.16	7.58	8.00	8.42
C $\frac{5}{8}$	3.40	5.06	3.74	5.56	4.08	6.07	4.43	6.57	4.77	7.08	5.11	7.58	5.45	8.08	8.60	9.10	9.60	10.1
H $\frac{3}{4}$	3.97	5.90	4.37	6.49	4.77	7.08	5.16	7.67	5.56	8.25	5.96	8.85	6.35	9.44	10.1	10.6	11.2	11.8
I $\frac{7}{8}$	4.82	7.16	5.30	7.88	5.79	8.60	6.27	9.31	6.75	10.0	7.24	10.8	7.72	11.5	12.2	12.9	13.6	14.3
I $\frac{1}{2}$	5.67	8.43	6.24	9.27	6.81	10.2	7.38	11.0	7.94	11.8	8.51	12.6	9.08	13.5	14.3	15.2	16.0	16.8
N $\frac{3}{4}$	7.09	10.5	7.80	11.6	8.52	12.6	9.22	13.7	9.93	14.7	10.6	15.8	11.4	16.9	17.9	19.0	20.0	21.0
E $\frac{1}{4}$	8.51	12.6	9.36	13.9	10.4	15.2	11.1	16.4	11.9	17.6	12.8	19.0	13.6	20.2	21.5	22.7	24.0	25.2
F $\frac{3}{8}$	9.92	14.8	10.9	16.2	11.9	17.7	12.9	19.2	13.9	20.6	14.9	22.2	15.9	23.6	25.1	26.5	28.0	29.5
E $\frac{1}{2}$	11.3	16.8	12.5	18.5	13.6	20.2	14.7	21.9	15.9	23.6	17.0	25.3	18.1	26.9	28.6	30.3	32.0	33.7
D $\frac{3}{4}$	13.6	20.2	15.0	22.2	16.4	24.3	17.7	26.3	19.1	28.3	20.4	30.4	21.8	32.4	34.4	36.4	40.4	40.4
R $\frac{1}{2}$	16.4	24.4	18.1	26.8	19.8	29.3	21.4	31.8	23.0	34.2	24.7	36.7	26.3	39.1	41.5	44.0	48.4	48.4
A $\frac{3}{4}$	20.4	30.3	22.5	33.4	24.5	36.4	26.6	39.4	28.6	42.4	30.6	45.5	32.7	48.5	51.5	54.6	60.7	60.7
D $\frac{1}{2}$	24.4	36.2	26.8	39.8	29.3	43.5	31.7	47.1	34.2	50.7	36.6	54.4	39.0	58.0	61.5	65.2	72.5	72.5
T $\frac{1}{2}$	29.5	43.8	32.4	48.2	35.4	52.6	38.4	56.9	41.3	61.3	44.2	65.7	47.2	70.0	74.5	78.8	87.6	87.6
E $\frac{3}{4}$	35.2	52.2	38.7	57.5	42.2	62.7	45.7	68.8	49.2	73.1	52.8	78.4	56.3	83.5	88.8	94.0	104	104
A $\frac{1}{2}$	40.8	60.7	44.9	66.7	49.0	72.8	53.2	78.8	57.2	84.9	61.3	91.0	65.4	97.0	103	109	115	121
T $\frac{3}{4}$	47.7	70.8	52.4	77.8	57.2	85.0	62.0	92.0	66.7	99.1	71.5	106	76.3	113.0	120	127	134	142
E $\frac{1}{2}$	56.7	84.3	62.4	92.7	68.1	101.0	73.8	110.0	79.4	118.0	85.1	127	90.8	135.0	143	152	160	168
E $\frac{3}{4}$	68.1	101.0	74.9	111.0	81.8	121.0	88.5	132.0	95.3	142.0	104.0	152	109.0	162.0	172	182	192	202

*Note: 12" Table is not available with power feed arrangement.

FEEDS OBTAINED ON CIRCULAR MILLING TABLES CORRESPONDING TO
DIAMETER OF WORK AND INDICATED FEED—FOR $\frac{3}{8}$ "-90" PER MIN. FEED RANGE

Dia. Work→ Size *Table→	1"		2"		3"		4"		5"		6"		7"		8"		9"	
	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"
I $\frac{3}{8}$	.042	.063	.085	.126	.128	.190	.170	.253	.213	.316	.255	.380	.298	.442	.340	.506	.384	.570
N $\frac{7}{16}$	.049	.074	.099	.148	.149	.222	.198	.295	.248	.369	.298	.443	.348	.516	.398	.590	.446	.665
D $\frac{9}{16}$	.064	.095	.128	.190	.192	.285	.255	.380	.320	.475	.383	.570	.447	.663	.510	.760	.575	.855
I $\frac{1}{8}$	.078	.116	.156	.232	.234	.348	.312	.464	.390	.580	.468	.695	.547	.810	.624	.928	.700	1.04
C $\frac{1}{4}$	.092	.137	.184	.275	.277	.412	.368	.550	.462	.686	.553	.822	.647	.958	.740	1.10	.830	1.14
A $\frac{3}{8}$	.106	.158	.213	.316	.319	.475	.425	.632	.532	.790	.638	.950	.745	1.11	.850	1.26	.957	1.42
T $\frac{1}{2}$	.128	.190	.256	.380	.383	.570	.510	.760	.640	.950	.765	1.14	.893	1.32	1.02	1.52	1.15	1.71
E $\frac{3}{4}$	.149	.222	.298	.444	.446	.664	.595	.884	.744	1.10	.892	1.32	1.04	1.54	1.19	1.77	1.34	1.99
D $\frac{1}{8}$	.184	.275	.370	.550	.553	.822	.737	1.10	.923	1.37	1.11	1.64	1.29	1.92	1.48	2.20	1.66	2.47
A $\frac{1}{4}$	.213	.316	.426	.632	.638	.950	.850	1.26	1.32	1.58	1.28	1.89	1.49	2.21	1.70	2.53	1.92	2.85
C $\frac{1}{2}$	.255	.380	.510	.760	.767	1.14	1.02	1.52	1.28	1.90	1.53	2.27	1.78	2.66	2.04	3.04	2.30	3.41
H $\frac{3}{4}$	.298	.443	.596	.886	.893	1.33	1.19	1.77	1.49	2.22	1.78	2.66	2.08	3.10	2.38	3.54	2.68	3.98
M $\frac{1}{8}$	.369	.548	.738	1.10	1.11	1.65	1.47	2.19	1.85	2.75	2.22	3.29	2.58	3.84	2.95	4.40	3.32	4.94
A $\frac{3}{4}$	.425	.633	.850	1.27	1.28	1.90	1.70	2.53	2.13	3.16	2.55	3.80	2.98	4.43	3.40	5.07	3.83	5.70
C $\frac{1}{4}$	.510	.760	1.02	1.52	1.53	2.28	2.04	3.04	2.55	3.80	3.06	4.55	3.57	5.32	4.09	6.08	4.60	6.83
H $\frac{1}{2}$	.596	.885	1.19	1.78	1.79	2.66	2.38	3.54	2.98	4.43	3.58	5.32	4.17	6.20	4.77	7.08	5.36	7.98
I $\frac{1}{2}$	.736	1.10	1.48	2.20	2.21	3.29	2.94	4.30	3.69	5.48	4.43	6.58	5.17	7.67	5.90	8.78	6.64	9.88
N $\frac{3}{4}$	.850	1.26	1.70	2.53	2.55	3.80	3.40	5.06	4.26	6.32	5.10	7.58	5.96	8.85	6.80	10.1	7.66	11.4
E $\frac{1}{8}$	1.02	1.52	2.04	3.04	3.06	4.56	4.08	6.08	5.12	7.60	6.12	9.10	7.15	10.6	8.18	12.8	9.20	13.6
E $\frac{1}{4}$	1.25	1.86	2.50	3.72	3.74	5.58	4.98	7.42	6.24	9.28	7.48	11.1	8.73	13.0	10.0	14.8	11.2	16.7
13	1.48	2.19	2.96	4.39	4.42	6.58	5.90	8.77	7.38	11.0	8.84	13.2	10.3	15.3	11.8	17.5	13.3	19.7
F $\frac{1}{2}$	1.73	2.58	3.46	5.15	5.20	7.73	6.90	10.3	8.66	12.8	10.4	15.4	12.1	18.0	13.8	20.6	15.6	23.2
E $\frac{3}{8}$	2.15	3.20	4.32	6.40	6.47	9.62	8.60	12.8	10.8	16.0	12.9	19.2	15.1	22.4	17.3	25.6	19.4	28.8
E $\frac{1}{2}$	2.50	3.72	5.00	7.44	7.48	11.1	9.96	14.8	12.5	18.6	15.0	22.2	17.5	26.0	20.0	29.6	22.5	33.4
E $\frac{3}{4}$	3.06	4.55	6.12	9.10	9.20	13.7	12.2	18.2	15.3	22.8	18.4	27.3	21.4	31.8	24.5	36.5	27.5	41.0
D $\frac{1}{2}$	3.52	5.24	7.04	10.5	10.5	15.7	14.0	20.9	17.6	26.2	21.1	31.4	24.7	36.6	28.2	41.8	31.7	47.0
39	4.42	6.58	8.86	13.2	13.3	19.8	17.7	25.3	22.2	32.9	26.5	39.5	31.0	46.0	35.4	52.6	39.8	59.2
45	5.10	7.60	10.2	15.2	15.3	22.8	20.4	30.3	25.6	38.0	30.6	45.5	35.8	53.0	40.8	60.8	46.0	68.3
R $\frac{1}{2}$	6.10	9.10	12.3	18.2	18.4	27.3	24.5	36.5	30.7	45.5	36.7	54.6	42.9	63.7	49.0	73.0	55.2	82.0
A $\frac{3}{4}$	7.13	10.3	14.3	21.3	21.5	31.9	28.6	42.5	35.8	53.2	42.9	63.8	50.0	74.3	57.2	85.0	64.3	95.8
T $\frac{1}{2}$	8.95	13.3	18.0	26.7	26.9	40.0	35.8	53.4	44.9	66.7	53.8	80.0	62.8	93.0	71.8	106	81.8	120
E $\frac{3}{4}$	10.2	15.2	20.4	30.4	30.6	45.6	40.8	60.8	51.2	76.0	61.3	91.0	71.5	106	81.8	122	92.0	137

*Note: 12" Table is not available with power feed arrangement.

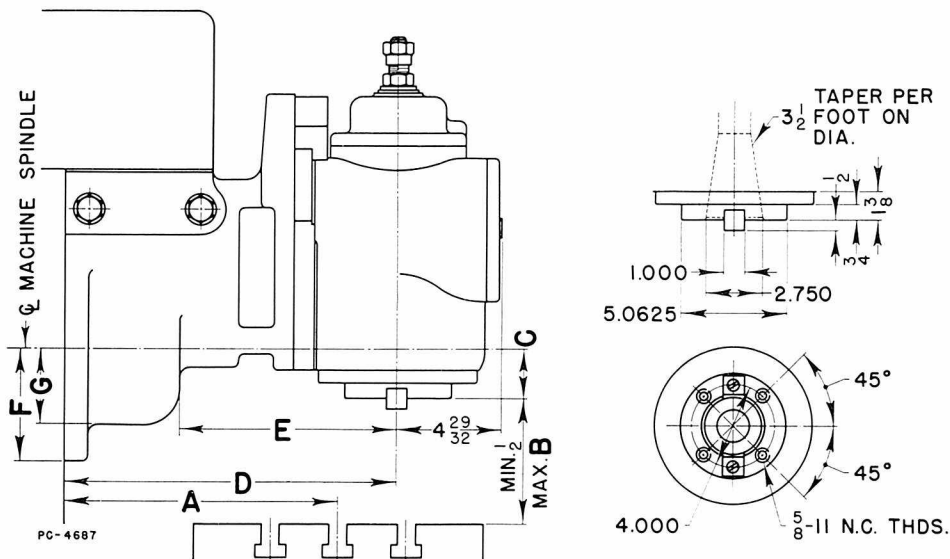
FEEDS OBTAINED ON CIRCULAR MILLING TABLES CORRESPONDING TO
DIAMETER OF WORK AND INDICATED FEED—FOR $\frac{3}{8}$ "-90" PER MIN. FEED RANGE

Dia. Work→	10"		11"		12"		13"		14"		15"		16"		17"	18"	19"	20"
	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	16"	20" and 24"	20" and 24" and 24"	20" and 24" and 24"	20" and 24" and 24"	20" and 24" and 24"
I $\frac{3}{8}$	.425	.632	.467	.696	.510	.760	.552	.822	.595	.884	.637	.950	.680	1.01	1.08	1.14	1.20	1.27
N $\frac{1}{16}$	.496	.737	.545	.812	.595	.885	.645	.960	.693	1.03	.743	1.11	.793	1.18	1.15	1.32	1.40	1.48
D $\frac{9}{16}$	.640	.950	.700	1.04	.768	1.14	.830	1.23	.892	1.33	.955	1.42	1.02	1.52	1.61	1.70	1.80	1.90
I $\frac{1}{16}$	.780	1.16	.857	1.28	.937	1.39	1.01	1.23	1.09	1.62	1.17	1.74	1.24	1.85	1.97	2.08	2.20	2.32
I $\frac{3}{16}$	.922	1.37	1.01	1.51	1.11	1.64	1.20	1.78	1.29	1.92	1.38	2.06	1.47	2.19	2.33	2.46	2.60	2.75
C $\frac{1}{8}$	1.06	1.58	1.17	1.74	1.28	1.90	1.38	2.05	1.48	2.21	1.59	2.37	1.70	2.53	2.68	2.84	3.00	3.16
A $\frac{1}{8}$	1.28	1.80	1.40	2.08	1.53	2.27	1.66	2.47	1.78	2.61	1.91	2.85	2.04	3.04	3.22	3.41	3.60	3.80
T $\frac{1}{8}$	1.49	2.22	1.64	2.43	1.78	2.65	1.93	2.87	2.08	3.10	2.23	3.32	2.38	3.54	3.76	3.97	4.20	4.43
E $\frac{1}{8}$	1.84	2.74	2.03	3.02	2.22	3.29	2.40	3.56	2.57	3.84	2.76	4.11	2.95	4.40	4.66	4.93	5.20	5.48
D $\frac{1}{16}$	2.13	3.16	2.33	3.48	2.55	3.79	2.76	4.10	2.97	4.42	3.18	4.74	3.40	5.03	5.38	5.68	6.00	6.32
A $\frac{1}{16}$	2.55	3.80	2.80	4.18	3.07	4.55	3.32	4.93	3.56	5.30	3.83	5.70	4.08	6.08	6.45	6.82	7.20	7.60
T $\frac{1}{16}$	2.98	4.42	3.27	4.88	3.57	5.30	3.87	5.75	4.16	6.20	4.46	6.63	4.76	7.10	7.52	7.95	8.50	8.85
M $\frac{3}{4}$	3.69	5.48	4.05	6.03	4.43	6.58	4.80	7.12	5.16	7.67	5.53	8.22	5.90	8.78	9.30	9.84	10.4	11.0
A $\frac{3}{4}$	4.26	6.32	4.67	6.96	5.10	7.60	5.52	8.22	5.94	8.85	6.38	9.50	6.80	10.1	10.7	11.4	12.0	12.6
C $\frac{1}{2}$	5.12	7.60	5.60	8.35	6.13	9.10	6.63	9.85	7.13	10.6	7.65	11.4	8.16	12.1	12.9	13.6	14.4	15.2
H $\frac{1}{2}$	5.96	8.88	6.54	9.75	7.15	10.6	7.73	11.5	8.32	12.4	8.92	13.3	9.50	14.2	15.0	15.9	16.8	17.7
I $\frac{1}{2}$	7.38	11.0	8.20	12.1	8.85	13.2	9.58	14.2	10.3	15.3	11.0	16.4	11.8	17.5	18.6	19.7	20.8	21.9
I $\frac{7}{16}$	8.50	12.6	9.34	13.9	10.2	15.2	11.0	16.4	11.9	17.7	12.8	19.0	13.6	20.2	21.5	22.7	24.0	25.3
N $\frac{1}{2}$	10.2	15.2	11.2	16.7	12.2	18.2	13.3	19.7	14.3	21.2	15.3	22.8	16.3	24.3	25.8	27.3	28.8	30.4
E $\frac{1}{2}$	12.5	18.6	13.7	20.4	15.0	22.2	16.2	24.1	17.4	26.0	18.7	27.8	19.9	29.7	31.5	33.4	35.2	37.1
F $\frac{1}{2}$	14.8	21.9	16.2	24.1	17.7	26.3	19.2	28.5	20.6	30.7	22.1	32.9	23.5	35.1	37.3	39.4	41.6	43.9
E $\frac{15}{16}$	17.3	25.7	19.0	28.3	21.8	30.8	22.5	33.5	24.2	36.0	25.9	38.6	27.7	41.2	43.7	46.3	48.8	51.4
E $\frac{19}{16}$	21.6	32.0	23.7	35.3	25.9	38.5	28.0	41.7	30.1	44.8	32.3	48.1	34.5	51.3	54.4	57.6	60.8	64.2
E $\frac{22}{16}$	25.0	37.1	27.4	40.9	30.0	44.5	32.4	48.3	34.9	52.0	37.4	55.7	40.0	59.3	63.0	66.7	70.4	74.3
E $\frac{27}{16}$	30.6	45.5	33.6	50.2	36.8	54.6	39.8	59.2	42.8	63.7	45.9	68.3	49.0	73.0	77.3	81.8	86.4	91.0
D $\frac{31}{16}$	35.2	52.2	38.6	57.5	42.2	62.8	45.6	68.0	49.2	73.0	52.7	78.3	56.2	83.8	88.8	94.0	99.2	104
39	44.2	65.8	48.6	72.4	53.2	79.0	57.5	85.5	61.8	92.0	66.3	98.5	70.8	105	112	118	125	132
R $\frac{45}{16}$	51.0	76.0	56.2	83.5	60.7	91.0	66.3	98.5	71.3	106	76.5	114	81.5	121	129	136	144	152
54	61.3	91.0	67.2	100	73.5	109	79.5	118	85.5	128	91.8	136	97.8	146	155	164	173	182
A $\frac{63}{16}$	71.5	106	78.5	117	85.8	128	93.0	138	100	148	107	159	114	170	181	191	202	212
T $\frac{79}{16}$	89.7	133	98.5	183	108	160	116	173	125	186	134	200	143	213	226	239	253	267
E $\frac{90}{16}$	102	152	112	167	122	182	133	197	143	212	153	228	163	243	258	273	288	304

*Note: 12" Table is not available with power feed arrangement.

VERTICAL MILLING ATTACHMENT

This attachment will permit you to perform vertical milling operations on a plain or universal style machine. Attachment spindle is the same size as the machine spindle to permit interchangeability of shell end mill arbors, collet adapters, etc. Spindle speeds are 1 to 1 ratio of the machine speeds. The spindle may be swiveled 90° (45° either way from the vertical) in a plane parallel to the face of the machine column.



Machine Size	Style	A		B	C	D	E	F	G	Longitudinal Range of Machine	Net Weight Pounds Approx.	Shipping Weight Pounds Approx.
		Max.	Min.									
210-12	Plain	19 $\frac{1}{16}$ "	9 $\frac{1}{16}$ "	16 $\frac{3}{8}$ "	2 $\frac{3}{8}$ "	12 $\frac{1}{2}$ "	7"	5 $\frac{3}{8}$ "	3 $\frac{3}{8}$ "	28"	270	330
	Univ.	19 $\frac{3}{4}$ "	9 $\frac{3}{4}$ "	15 $\frac{5}{8}$ "								
310-12	Plain	19 $\frac{1}{16}$ "	9 $\frac{1}{16}$ "	16 $\frac{3}{8}$ "	2 $\frac{3}{8}$ "	16"	10 $\frac{1}{2}$ "	5 $\frac{3}{8}$ "	3 $\frac{3}{8}$ "	34"	340	420
	Univ.	19 $\frac{3}{4}$ "	9 $\frac{3}{4}$ "	15 $\frac{5}{8}$ "								
315-15	Plain	23 $\frac{1}{16}$ "	11 $\frac{1}{16}$ "	17 $\frac{3}{8}$ "	2 $\frac{3}{8}$ "	16"	10 $\frac{1}{2}$ "	5 $\frac{3}{8}$ "	3 $\frac{3}{8}$ "	34"	340	420
	Univ.	23 $\frac{3}{16}$ "	11 $\frac{3}{16}$ "	16 $\frac{5}{8}$ "								
415-15	Plain	23 $\frac{1}{16}$ "	11 $\frac{1}{16}$ "	17 $\frac{3}{8}$ "	2 $\frac{3}{8}$ "	16"	10 $\frac{1}{2}$ "	5 $\frac{3}{8}$ "	3 $\frac{3}{8}$ "	42"	340	420
	Univ.	23 $\frac{3}{16}$ "	11 $\frac{3}{16}$ "	16 $\frac{3}{8}$ "								
420-16	Plain	25 $\frac{1}{2}$ "	11 $\frac{1}{2}$ "	17 $\frac{5}{8}$ "	2 $\frac{3}{8}$ "	16"	10 $\frac{1}{2}$ "	5 $\frac{3}{8}$ "	3 $\frac{3}{8}$ "	42"	340	420
	Univ.	26"	12"	16 $\frac{3}{8}$ "								
520-16	Plain	25 $\frac{1}{2}$ "	11 $\frac{1}{2}$ "	17 $\frac{5}{8}$ "	2 $\frac{3}{8}$ "	16"	10 $\frac{1}{2}$ "	5 $\frac{3}{8}$ "	3 $\frac{3}{8}$ "	50"	340	420
	Univ.	26"	12"	16 $\frac{5}{8}$ "								

Figure 91A
Dimensions—Vertical Milling Attachment

INDEPENDENT OVERHEAD SPINDLE

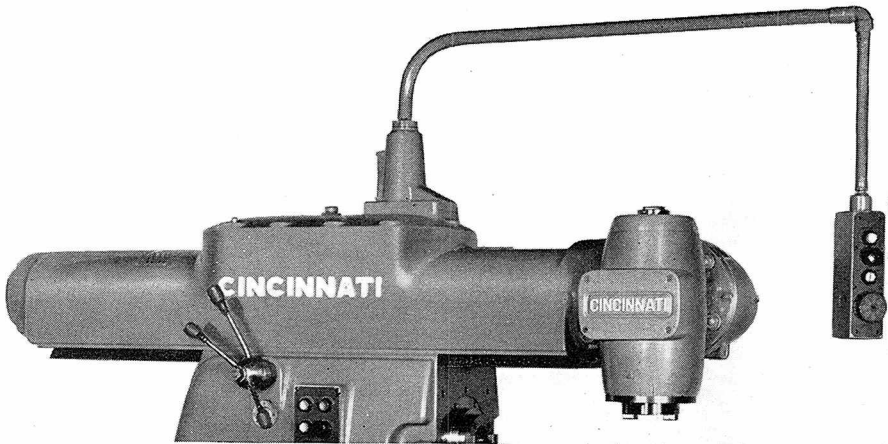


Figure 92A
Independent Overhead Spindle

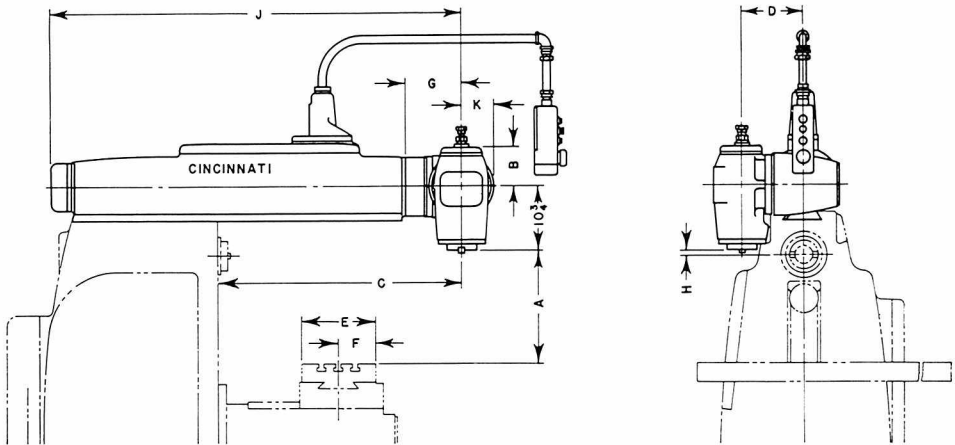
This unit, shown in Figure 92A, is a completely self-contained device built into a special overarm which replaces the standard machine overarm. Individually motor driven, the functioning is completely independent of the machine power source. The machine spindle is free for use at any time, either independently, or in combination with the Independent Overhead Spindle.

Eight speeds are available, being selected by the walking pendant control. Four series of spindle speeds are available, selection being made at time order is placed. The low series includes spindle speeds of 50-750 rpm. or 75-1125 rpm. and the high series includes spindle speeds of 100-1500 rpm. or 150-2250 rpm. A spindle reverse switch, mounted in the pendant control box, provides instant selection of either direction of spindle rotation.

The head is carried on a pair of swivel mounts each of which can be swiveled a full 360 degrees for completely universal positioning of the spindle. A zero positioning pin is provided for each swivel.

Spindle nose is No. 50 Milling Machine Standard, the same as the machine spindle nose, thereby permitting quick interchange of cutters between attachment spindle and machine spindle. Arbor supports can be mounted and dismounted from the independent overarm in the same manner as with the standard machine overarm, without interference from the swivel head.

ACCESSORIES AND ATTACHMENTS



SPECIFICATIONS—3-HP

Machine	*A		B	*C		D	E	F	G	H	J	K
	Max.	Min.		Max.	Min.							
No. 210-12 Dial Type}	20 $\frac{1}{8}$ "	1 $\frac{1}{8}$ "	6 $\frac{1}{2}$ "	40 $\frac{3}{8}$ "	9 $\frac{7}{8}$ "	10 $\frac{1}{4}$ "	12 $\frac{1}{4}$ "	6"	9 $\frac{1}{4}$ "	1 $\frac{1}{8}$ "	68 $\frac{1}{4}$ "	5 $\frac{1}{8}$ "
No. 310-12 Dial Type}												

NOTES: *Maximum dimension "A" is for Plain Machines. Subtract one inch for Universal Machines.

★For additional ranges, a minimum "C" dimension of minus 5" can be obtained with rear overarm support, available at extra cost.

SPECIFICATIONS—5-HP

Machine	*A		B	*C		D	E	F	G	H	J	K
	Max.	Min.		Max.	Min.							
No. 210-12 Dial Type}	21 $\frac{1}{8}$ "	2 $\frac{1}{8}$ "	7 $\frac{1}{8}$ "	41 $\frac{1}{8}$ "	10 $\frac{3}{8}$ "	10 $\frac{3}{16}$ "	12 $\frac{1}{4}$ "	6"	9 $\frac{7}{8}$ "	2 $\frac{1}{8}$ "	70 $\frac{1}{16}$ "	5 $\frac{7}{8}$ "
No. 310-12 Dial Type}												
No. 315-15 Dial Type}	23 $\frac{3}{8}$ "	3 $\frac{3}{8}$ "	7 $\frac{1}{8}$ "	44 $\frac{7}{16}$ "	10 $\frac{3}{8}$ "	10 $\frac{3}{16}$ "	15 $\frac{1}{4}$ "	7 $\frac{1}{2}$ "	9 $\frac{7}{8}$ "	3 $\frac{3}{8}$ "	80 $\frac{3}{16}$ "	5 $\frac{7}{8}$ "
No. 415-15 Dial Type}												
No. 420-16 Dial Type}	23 $\frac{3}{8}$ "	3 $\frac{3}{8}$ "	7 $\frac{1}{8}$ "	48 $\frac{3}{8}$ "	10 $\frac{3}{8}$ "	10 $\frac{3}{16}$ "	16 $\frac{1}{4}$ "	8"	9 $\frac{7}{8}$ "	3 $\frac{3}{8}$ "	80 $\frac{3}{16}$ "	5 $\frac{7}{8}$ "
No. 520-16 Dial Type}												

NOTES: *Maximum dimension "A" is for Plain Machines. Subtract one inch for Universal Machines.

★For additional ranges, a minimum "C" dimension of minus 6" can be obtained with rear overarm support, available at extra cost.

Figure 93A
Dimensions—Independent Overhead Spindle

UNIVERSAL MILLING ATTACHMENT

This attachment is used for helical milling operations. When milling helices on a plain machine the attachment can be swiveled to position the cutter to the correct helix angle. On universal machines the attachment can be used for helical angles greater than 45° . Most universal machine tables will only swivel approximately 45° .

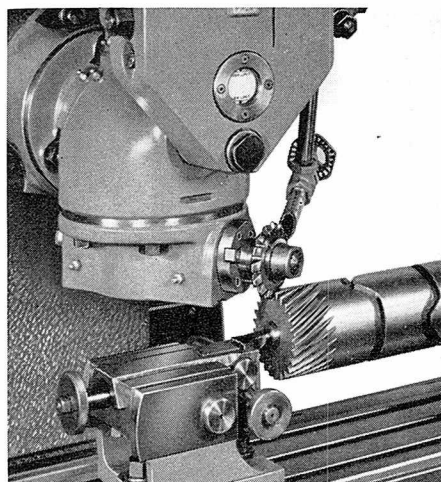
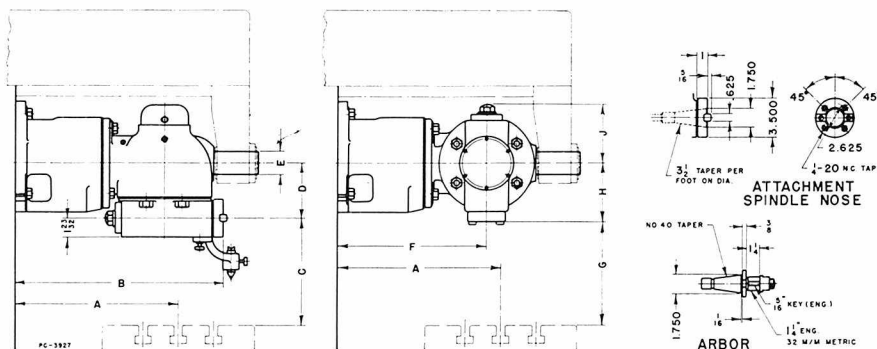


Figure 94A
Universal Milling Attachment



Machine Size	Style	A		B	C	D	E	F	G	H	J
		Max.	Min.		Max.						
210-12	Plain	$19\frac{7}{16}$	$9\frac{7}{16}$	$16\frac{1}{8}$	$13\frac{5}{8}$	$5\frac{3}{8}$	$2\frac{3}{32}$	$10\frac{11}{16}$	$13\frac{9}{16}$	$5\frac{7}{16}$	$5\frac{1}{4}$
	Univ.	$19\frac{3}{4}$	$9\frac{3}{4}$		$12\frac{5}{8}$				$12\frac{9}{16}$		
310-12	Plain	$21\frac{1}{16}$	$9\frac{7}{16}$	$19\frac{1}{8}$	$13\frac{5}{8}$	$5\frac{3}{8}$	$2\frac{1}{8}$	$13\frac{11}{16}$	$13\frac{9}{16}$	$5\frac{7}{16}$	$5\frac{1}{4}$
	Univ.	$21\frac{3}{4}$	$9\frac{3}{4}$		$12\frac{5}{8}$				$12\frac{9}{16}$		
315-15	Plain	$23\frac{1}{16}$	$11\frac{1}{16}$	$19\frac{1}{8}$	$14\frac{5}{8}$	$5\frac{3}{8}$	$2\frac{1}{8}$	$13\frac{11}{16}$	$14\frac{9}{16}$	$5\frac{7}{16}$	$5\frac{1}{4}$
	Univ.	$23\frac{3}{16}$	$11\frac{3}{16}$		$13\frac{5}{8}$				$13\frac{9}{16}$		
415-15	Plain	$25\frac{1}{16}$	$11\frac{1}{16}$	$19\frac{1}{8}$	$14\frac{5}{8}$	$5\frac{3}{8}$	$2\frac{1}{8}$	$13\frac{11}{16}$	$14\frac{9}{16}$	$5\frac{7}{16}$	$5\frac{1}{4}$
	Univ.	$25\frac{3}{16}$	$11\frac{3}{16}$		$13\frac{5}{8}$				$13\frac{9}{16}$		
420-16	Plain	$25\frac{1}{2}$	$11\frac{1}{2}$	$19\frac{1}{8}$	$14\frac{5}{8}$	$5\frac{3}{8}$	$2\frac{1}{8}$	$13\frac{11}{16}$	$14\frac{9}{16}$	$5\frac{7}{16}$	$5\frac{1}{4}$
	Univ.	26	12		$13\frac{5}{8}$				$13\frac{9}{16}$		
520-16	Plain	$27\frac{1}{2}$	$11\frac{1}{2}$	$19\frac{1}{8}$	$14\frac{5}{8}$	$5\frac{3}{8}$	$2\frac{1}{8}$	$13\frac{11}{16}$	$14\frac{9}{16}$	$5\frac{7}{16}$	$5\frac{1}{4}$
	Univ.	27	12		$13\frac{5}{8}$				$13\frac{9}{16}$		

Figure 94B
Dimensions—Universal Milling Attachment

HIGH SPEED UNIVERSAL MILLING ATTACHMENT

This attachment provides higher speeds for use with small to medium sized cutter for jobs requiring vertical or angular positions of the cutter. These attachments are for comparatively light work and are not suitable for face milling operations.

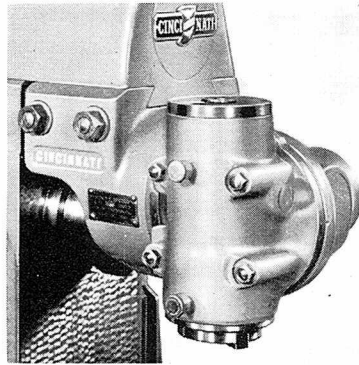
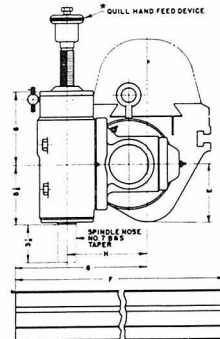
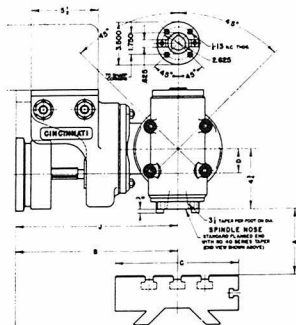


Figure 95A
High Speed Universal
Milling Attachment



Size	Style	A		B		C	D	E	F	G		H	J	
		Max.	Min.	Max.	Min.					Max.	Min.		Max.	Min.
210-12	Plain	15 ⁹ / ₁₆	3 ³ / ₈	19 ⁷ / ₁₆	9 ⁷ / ₁₆	12 ¹ / ₄	1 ³ / ₁₆	4 ¹¹ / ₁₆	59 ¹ / ₄	41 ¹ / ₁₆	13 ¹ / ₁₆	8 ³ / ₄	19 ⁹ / ₁₆	12 ⁹ / ₁₆
	Univ.	14 ⁹ / ₁₆	3 ³ / ₈	19 ³ / ₄	9 ³ / ₄					43 ¹¹ / ₁₆	15 ¹¹ / ₁₆			
310-12	Plain	15 ⁹ / ₁₆	3 ³ / ₈	21 ⁷ / ₁₆	9 ⁷ / ₁₆	12 ¹ / ₄	1 ³ / ₁₆	4 ¹¹ / ₁₆	65 ¹ / ₄	47 ⁷ / ₁₆	13 ¹ / ₁₆	8 ³ / ₄	19 ⁹ / ₁₆	12 ⁹ / ₁₆
	Univ.	14 ⁹ / ₁₆	3 ³ / ₈	21 ³ / ₄	9 ³ / ₄					49 ¹¹ / ₁₆	15 ¹¹ / ₁₆			
315-15	Plain	16 ³ / ₄	3 ³ / ₈	23 ¹ / ₁₆	11 ¹ / ₁₆	15 ¹ / ₄	1 ¹ / ₂	4 ¹³ / ₁₆	68 ¹ / ₂	50 ¹ / ₂	16 ¹ / ₂	8 ¹¹ / ₁₆	19 ⁹ / ₁₆	12 ⁹ / ₁₆
	Univ.	15 ³ / ₄	3 ³ / ₈	23 ³ / ₁₆	11 ³ / ₁₆					50 ¹ / ₂	16 ¹ / ₂			
415-15	Plain	16 ³ / ₄	3 ³ / ₈	25 ¹ / ₁₆	11 ¹ / ₁₆	15 ¹ / ₄	1 ¹ / ₂	4 ¹³ / ₁₆	76 ¹ / ₂	58 ¹ / ₂	16 ¹ / ₂	8 ¹¹ / ₁₆	19 ⁹ / ₁₆	12 ⁹ / ₁₆
	Univ.	15 ³ / ₄	3 ³ / ₈	25 ³ / ₁₆	11 ³ / ₁₆					58 ¹ / ₂	16 ¹ / ₂			
420-16	Plain	16 ³ / ₄	3 ³ / ₈	25 ¹ / ₂	11 ¹ / ₂	16 ¹ / ₄	1 ¹ / ₂	4 ¹³ / ₁₆	79 ³ / ₄	58 ¹ / ₂	16 ¹ / ₂	8 ¹¹ / ₁₆	19 ⁹ / ₁₆	12 ⁹ / ₁₆
	Univ.	15 ³ / ₄	3 ³ / ₈	26	12					58 ¹ / ₂	16 ¹ / ₂			
520-16	Plain	16 ³ / ₄	3 ³ / ₈	27 ¹ / ₂	11 ¹ / ₂	16 ¹ / ₄	1 ¹ / ₂	4 ¹³ / ₁₆	87 ³ / ₄	66 ¹ / ₂	16 ¹ / ₂	8 ¹¹ / ₁₆	19 ⁹ / ₁₆	12 ⁹ / ₁₆
	Univ.	15 ³ / ₄	3 ³ / ₈	27	12					66 ¹ / ₂	16 ¹ / ₂			

*Note: Dimension "A" is for attachments without quill.

Figure 95B
Dimensions—High Speed Universal Milling Attachment

CINCINNATI DIAL TYPE MILLING MACHINES

The attachment is driven from the machine spindle by means of a splined shaft, fitting into an adapter mounted in the spindle nose. This method of driving provides a 7" range of cross adjustment for the attachment, a useful feature on large work.

Spindle speeds are 1.475 x speed indicated on the machine speed dial. The spindle swivel a full 360° in a plane parallel to the face of the column, 90° (45° each way from vertical) in a plane at right angles to the face of the column. Spindle nose of attachment is No. 40 National Standard.

A Quill Hand Feed Attachment, available at extra cost, provides a 3" axial adjustment of the cutter when this should be desired. When this device is used, the spindle nose is No. 7 B.&S.

Lubrication. The High Speed Universal Milling Attachment must be lubricated daily while in use. In the grease nipple for the lower spindle bearing, use only medium sponge short fibre grease, sodium soap base. There are three other grease nipples on the attachment proper, and one oil button in the quill feed hand knob. Periodically apply cup grease and machine oil, respectively.

Removing Quill Hand Feed Attachment. When the attachment is equipped with the quill hand feed device, and it is desirable to remove it so that cutters can be inserted in the attachment, proceed as follows:

1. Loosen the socket head, set screw in the periphery of the quill feed hand knob. Tap the screw lightly to loosen the lock shoe beneath it.
2. In the top end of the knob is a retainer nut. Remove this nut with a spanner wrench.
3. A slotted adjusting nut is now visible. Remove this nut and its lock washer.

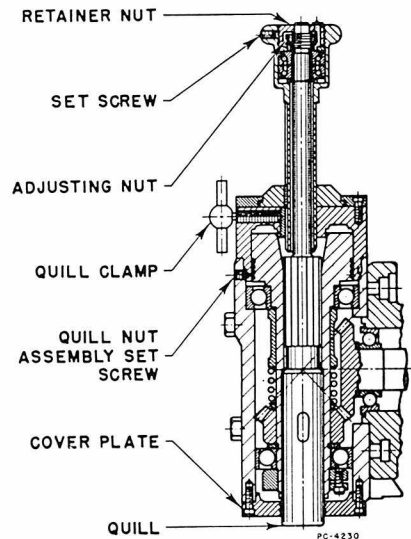


Figure 96A
Section Through Attachment
with Quill Hand Feed

ACCESSORIES AND ATTACHMENTS

4. Grasp the cutter shank end of the quill and pull it downward through the attachment. Replace the lock unit and washer on the quill so they will not become lost. To protect the ball bearings, also replace the retainer nut in the hand knob.
5. Remove the set screw from the body of the attachment, near the quill nut assembly.
6. Unscrew the remainder of the quill device from the body of the attachment.
7. Fit the dust cover in place and lock it with the set screw.
8. Assemble the two driving keys in the attachment spindle.
9. Remove the four screws which hold the cover plate on the housing at the rear of the spindle, and remove the plate.
10. Drive the draw-in bolt centering bushing into the rear end of the spindle.
11. Replace the cover plate.

SLOTING ATTACHMENT

This attachment is useful for slotting, keyway-cutting and similar operations when a slotter is not available. It mounts on the face of the column and is driven by the machine spindle. An adjustable driving crank provides adjustment of stroke length from 0" to 4" and a graduated scale is provided to simplify adjustments of stroke length. The tool slide can be positioned at any desired angle through a full 360 degrees, a graduated scale being provided to simplify accurate positioning. The number of strokes per minute of the tool slide is the same as the spindle speed indicated on the speed dial.

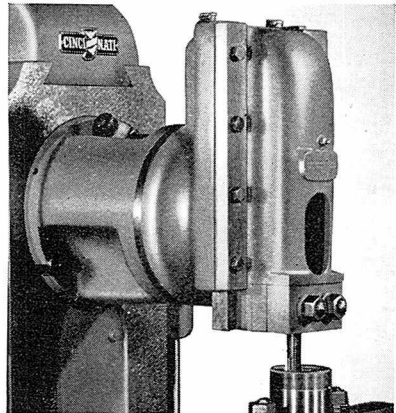


Figure 97A
Slotting Attachment

RACK MILLING ATTACHMENT

This attachment mounts on the face of the column and the outboard end is supported in the machine arbor support. Standard cutters fit directly on the attachment spindle and narrow slotting or side milling cutters can be used for operations which can be more conveniently performed with the machine cross feed. The attachment has a $1\frac{1}{4}$ " diameter spindle, will take cutters up to $4\frac{3}{4}$ " in diameter and work up to $5\frac{3}{8}$ " wide. Attachment spindle speed is the same as the machine spindle speed indicated on the speed-dial.

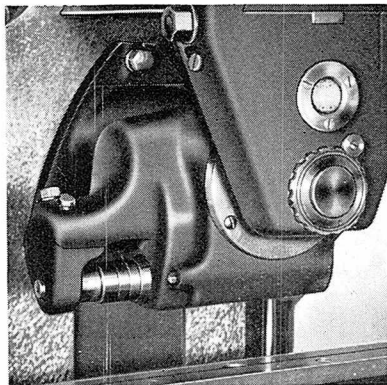


Figure 98A
Rack Milling Attachment

SHORT AND LONG LEAD DRIVING MECHANISM

The Short and Long Lead Driving Mechanism may be obtained at extra cost for all universal Knee-and-Column Milling Machines. Complementary parts must be built into the machine at the factory. Has a standard lead range of .010" to 1000" or (on demand) .025" to 3000", with no more than the usual number of change gears. Complete instructions are contained in a separate booklet. "Table of Leads—Short and Long Lead Driving Mechanism for CINCINNATI Universal Milling Machines", a copy of which accompanies each machine equipped with this equipment.

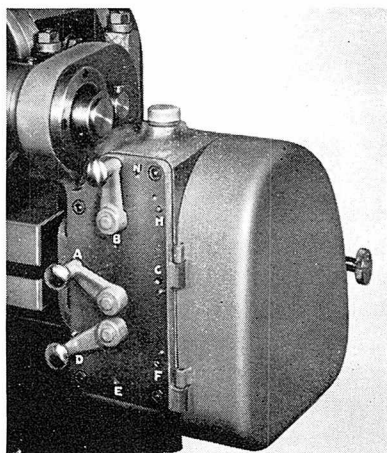


Figure 98B
Short and Long Lead
Driving Mechanism

HAND QUILL FEED DEVICE

This unit mounts either directly to the face of the Independent Overhead Spindle or to a 90° housing as shown in Figure 99A. Very useful in permitting operator to drill holes at any desired angle. The 3" maximum vertical movement of the quill which has a No. 40 N.S. taper spindle, is controlled by the hand-wheel on the front of the spindle housing. Spindle speeds are the same as those listed under specifications for the Independent Overhead Spindle (Page 92).

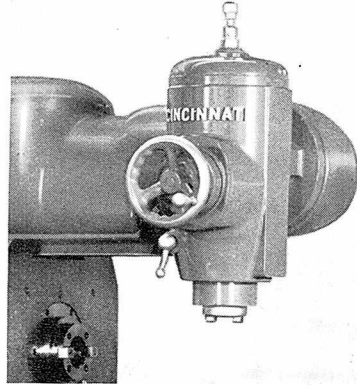


Figure 99A
Hand Quill Feed Device

METHOD OF CALCULATING MACHINING TIME

The actual cutting time for milling any piece of work may be calculated from the following formula:

$$T = \frac{L + A + O}{F}$$

T = Actual Milling Time in Minutes.

L = Length of Cut in Inches.

A = Approach of Cutter in Inches.

O = Over-travel of Cutter in Inches.

F = Feed in Inches per Minute.

The approach of the cutter is the distance the table must move the work into the cutter before full cutting depth or width is attained. (Dimension "A" in Figures 101A, 101B, and 102A).

The over-travel of the cutter is the distance the table must travel in power feed minus the total length of the cut. It is a safety factor to allow for variations in the length of the work piece and in clamping.

The feed is the most important factor, but there are such wide variations in feed depending upon the cutter, material, and the method of holding the work that the judgment of the set up man or operator must be relied upon to determine the correct feed. A discussion of feeds and speeds is contained in our booklet "Milling Machine Practice" a copy of which may be obtained from the factory.

Example: Suppose a cast-iron bracket is to be milled on one side, under the following conditions of feed, length of cut, etc. Calculate the actual cutting time.

Length of Cut 8"
 Width of Cut 4"
 Diameter of End Mill 6"
 Over-travel assume $\frac{1}{4}$ "
 Feed 11" per minute

Then $L = 8''$

$A = .77''$ (See table entitled "Approach of Cutter for End Mills and Face Mills", page 102).

$O = \frac{1}{4}''$

$F = 11''$

$$\text{And } T = \frac{.8 + .77 + .25}{11} = .82 \text{ minutes}$$

Total time, floor to floor = .82 + Handling Time + Time to Clear Work of Cutters.

CALCULATING MACHINING TIME

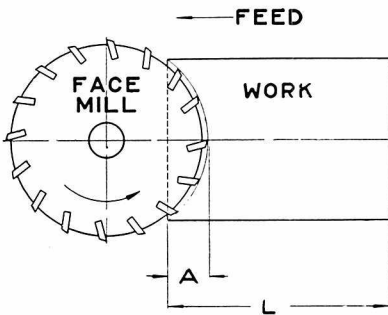


Figure 101A

Approach of Cutter (A) for Face and End Mills, with Center of Cutter Approximately in Line with Center of work.

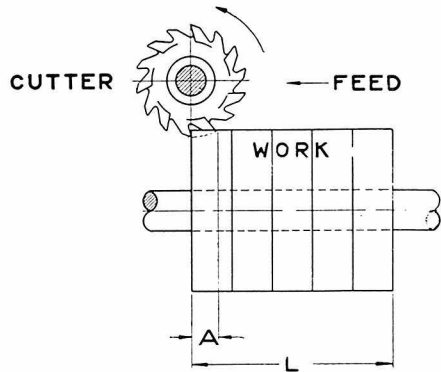


Figure 101B

Approach of Cutter (A) for Slab Milling, Keyway Cutting, Gear Cutting, Sawing, etc.

Example: Suppose a gang of five gear blanks are to be milled between the centers of a 10" Dividing Head, under the following conditions of feed, depth of cut, etc. Calculate the actual cutting time.

Width of Gear Face	1"
Whole Depth of Tooth	.270"
Diameter of Cutter	2 3/4"
Over-travel	assume 1/8"
Feed	9" per minute

Then $L = 5''$ (Five gears, each 1" wide).

$A = .79''$ (See table entitled "Approach of Cutter for Spiral Mills, Keyway, Cutters, Saws, etc." page 103).

$O = 1/8''$

$F = 9''$

$$\text{And } T \text{ per tooth} = \frac{5 + .79 + .125}{9} = .66 \text{ minutes}$$

Total time floor to floor:

$$= \frac{(.66 \times \text{No. of teeth}) + (\text{indexing time for one tooth} \times \text{No. of teeth} - 1)}{5}$$

$$+ \frac{\text{handling time} + \text{time to clear work of cutters.}}{5}$$

CINCINNATI DIAL TYPE MILLING MACHINES

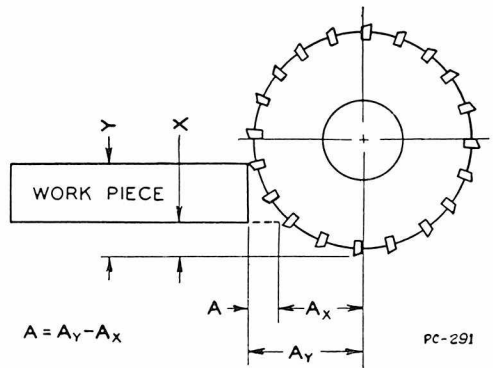


Figure 102A

Approach of Cutter (A) for Face and End Mills,
with Center of Cutter Offset from Center of Work

Example: If we have a part which requires a cut with an end mill or a face mill, and the center-line of the work does not coincide with the center of the cutter Figure 102A, the approach cannot be read directly from the table. Assuming an extreme condition, suppose we have an 8" diameter face mill taking a 2½" width of cut, and that one edge of the work is 1½" from the periphery of the cutter (dimension "X" in Figure 102A), while the opposite edge is 4" from the periphery (dimension "Y" = 1½" + 2½"). Then the approach of the cutter is the difference between the approach for a 4" depth of cut and a 1½" depth of cut. In the table entitled "Approach of Cutter for Spiral Mills, Keyway Cutters, Saws, etc.", the approach for an 8" cutter at a 4" depth is 4", while at a 1½" depth, it is 3.12". The difference between 4" and 3.12" equals .88", the correct approach in this particular case:

Approach of Cutter for End Mills and Face Mills
(Center of Cutter Approximately in Line with Center of Work)

Diam. of Mill	WIDTH OF CUT											
	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"
1	.5											
1½	.192											
2	.135	1.										
2½	.105	.5										
3	.09	.37	1.5									
4	.07	.27	.68	2.								
5	.05	.24	.5	1.	2.5							
6	.04	.18	.4	.77	1.34	3.						
7½	.04	.14	.32	.59	.96	1.51	2.63					
8	.033	.13	.291	.54	.88	1.36	2.07	4.				
10	.025	.10	.23	.43	.56	1.00	1.43	2.	2.82	5.		
12	.020	.08	.19	.35	.54	.81	1.13	1.53	2.04	2.69	3.6	6.

How to Read the Table: Follow down the column headed "Diam. of Mill" until you come to the diameter of cutter which you are using. Follow across to the right until you come to the column under the **width** of cut which the cutter is taking. The figure given is the approach of the cutter.

Example: 10" diameter face mill; 8" width of cut; approach of cutter is 2".

CALCULATING MACHINING TIME

Approach of Cutter for Spiral Mills, Keyway Cutters, Saws, Etc.

Diam. of Mill	DEPTH OF CUT											
	$\frac{1}{16}''$	$\frac{1}{8}''$	$\frac{3}{16}''$	$\frac{1}{4}''$	$\frac{5}{16}''$	$\frac{1}{2}''$	$\frac{3}{4}''$	1"	$1\frac{1}{2}''$	2"	3"	4"
$1\frac{1}{4}$	.272	.37	.44	.50	.57	.612						
$1\frac{1}{2}$	.299	.41	.49	.56	.65	.71	.75					
$1\frac{3}{4}$	.32	.45	.54	.61	.72	.79	.87					
2	.35	.48	.58	.66	.78	.87	.97	1.00				
$2\frac{1}{4}$	.37	.52	.62	.71	.84	.93	1.06	1.12				
$2\frac{1}{2}$	.39	.54	.66	.75	.89	1.00	1.15	1.22				
$2\frac{3}{4}$	.41	.57	.69	.79	.94	1.06	1.22	1.32				
3	.43	.60	.73	.83	.99	1.12	1.30	1.41	1.50			
$3\frac{1}{4}$	.45	.63	.76	.87	1.04	1.17	1.37	1.50	1.62			
$3\frac{1}{2}$	.46	.65	.79	.91	1.08	1.22	1.44	1.58	1.73			
$3\frac{3}{4}$	.48	.67	.82	.93	1.13	1.28	1.50	1.66	1.84			
4	.49	.70	.85	.97	1.17	1.32	1.56	1.73	1.94	2.00		
$4\frac{1}{4}$	.51	.72	.87	1.00	1.21	1.37	1.62	1.80	2.03	2.12		
$4\frac{1}{2}$	.53	.74	.90	1.03	1.24	1.41	1.67	1.87	2.12	2.24		
$4\frac{3}{4}$	.54	.76	.92	1.06	1.28	1.46	1.73	1.93	2.21	2.35		
5	.56	.78	.95	1.09	1.32	1.50	1.79	2.00	2.29	2.45		
$5\frac{1}{2}$	.58	.82	1.00	1.14	1.39	1.58	1.89	2.12	2.45	2.64		
6	.61	.86	1.04	1.20	1.45	1.66	1.98	2.24	2.60	2.83	3.00	
$6\frac{1}{2}$	.634	.89	1.09	1.25	1.51	1.73	2.08	2.35	2.74	3.00	3.24	
7	.658	.93	1.13	1.30	1.58	1.80	2.17	2.45	2.87	3.16	3.46	
$7\frac{1}{2}$	.68	.95	1.17	1.35	1.63	1.87	2.25	2.55	3.00	3.32	3.67	
8	.71	.99	1.21	1.39	1.69	1.94	2.33	2.65	3.12	3.46	3.87	4.00
$8\frac{1}{2}$	.73	1.03	1.25	1.44	1.74	2.00	2.41	2.74	3.24	3.61	4.06	4.24
9	.75	1.05	1.28	1.48	1.80	2.06	2.49	2.83	3.36	3.74	4.24	4.47
$9\frac{1}{2}$	.77	1.08	1.32	1.52	1.85	2.12	2.56	2.92	3.47	3.88	4.42	4.69
10	.79	1.11	1.35	1.56	1.90	2.18	2.63	3.00	3.57	4.00	4.58	4.90
$10\frac{1}{2}$	.81	1.14	1.39	1.60	1.95	2.24	2.71	3.08	3.67	4.12	4.75	5.10
11	.83	1.17	1.42	1.64	2.00	2.29	2.77	3.16	3.77	4.24	4.89	5.29
$11\frac{1}{2}$	.85	1.19	1.46	1.68	2.04	2.34	2.84	3.24	3.87	4.36	5.04	5.48
12	.86	1.22	1.49	1.72	2.09	2.40	2.91	3.32	3.97	4.47	5.19	5.65

How to Read the Table—Follow down the column headed "Diam. of Mill" until you come to the diameter of cutter which you are using. Follow across to the right until you come to the column under the **depth** of cut which the cutter is taking. The figure given is the approach of the cutter.

Example: $2\frac{3}{4}''$ diameter cutter, $\frac{1}{4}''$ depth of cut; approach of cutter is .79"

INDEX TABLES (Numerical Divisions)

For Standard Dividing Head Plate and Large Plate of Wide Range Divider
(See Pages 65 and 66 for method of calculating angular spacings and divisions
not listed for the wide range divider)

Table of divisions obtainable with the standard Index Plate and the large plate of the Wide Range Divider, used with Dividing Heads.

The plates are drilled on both sides with circles of holes equally spaced.
The number of holes in the circles are as follows:

Standard Dividing Head Plate { First Side—24-25-28-30-34-37-38-39-41-42-43
Second Side—46-47-49-51-53-54-57-58-59-62-66

Large Plate of Wide Range Divider { First Side—24-28-30-34-37-38-39-41-42-43-100
Second Side—46-47-49-51-53-54-57-58-59-62-66

No. of Divisions	Circle	Turns	Spaces	No. of Divisions	Circle	Turns	Spaces	No. of Divisions	Circle	Spaces	No. of Divisions	Circle	Spaces	No. of Divisions	Circle	Spaces	No. of Divisions	Circle	Spaces
2	Any	20	...	37	37	1	3	80	24	12	148	37	10	248	62	10	460	46	4
3	24	13	8	38	38	1	2	82	41	20	150	30	8	250	25	4	464	58	5
4	Any	10	...	39	39	1	1	84	42	20	152	38	10	255	51	8	470	47	4
5	Any	8	...	40	Any	1	...	85	34	16	155	62	16	260	39	6	472	59	5
6	24	6	16	41	41	...	40	86	43	20	156	39	10	264	66	10	480	24	2
7	28	5	20	42	42	...	40	88	66	30	160	28	7	270	54	8	490	49	4
8	Any	5	...	43	43	...	40	90	54	24	164	41	10	272	34	5	496	62	5
9	54	4	24	44	66	...	60	92	46	20	165	66	16	280	28	4	500	25	2
10	Any	4	...	45	54	...	48	94	47	20	168	42	10	290	58	8	510	51	4
11	66	3	42	46	46	...	40	95	38	16	170	34	8	296	37	5	520	39	3
12	24	3	8	47	47	...	40	96	24	10	172	43	10	300	30	4	528	66	5
13	39	3	3	48	24	...	20	98	49	20	176	66	15	304	38	5	530	53	4
14	49	2	42	49	49	...	40	100	25	10	180	54	12	310	62	8	540	54	4
15	24	2	16	50	25	...	20	102	51	20	184	46	10	312	39	5	560	28	2
16	24	2	12	51	51	...	40	104	39	15	185	37	8	320	24	3	570	57	4
17	34	2	12	52	39	...	30	105	42	16	188	47	10	328	41	5	580	58	4
18	54	2	12	53	53	...	40	106	53	20	190	38	8	330	66	8	590	59	4
19	38	2	4	54	54	...	40	108	54	20	192	24	5	336	42	5	600	30	2
20	Any	2	...	55	66	...	48	110	66	24	195	39	8	340	34	4	620	62	4
21	42	1	38	56	28	...	20	112	28	10	196	49	10	344	43	5	660	66	4
22	66	1	54	57	57	...	40	114	57	20	200	30	6	360	54	6	680	34	2
23	46	1	34	58	58	...	40	115	46	16	204	51	10	368	46	5	720	54	3
24	24	1	16	59	59	...	40	116	58	20	205	41	8	370	37	4	740	37	2
25	25	1	15	60	24	...	16	118	59	20	210	42	8	376	47	5	760	38	2
26	39	1	21	62	62	...	40	120	24	8	212	53	10	380	38	4	780	39	2
27	54	1	26	64	24	...	15	124	62	20	215	43	8	390	39	4	820	41	2
28	42	1	18	65	39	...	24	125	25	8	216	54	10	392	49	5	840	42	2
29	58	1	22	66	66	...	40	130	39	12	220	66	12	400	30	3	860	43	2
30	24	1	8	68	34	...	20	132	66	20	224	28	5	408	51	5	880	66	3
31	62	1	18	70	28	...	16	135	54	16	228	57	10	410	41	4	920	46	2
32	28	1	7	72	54	...	30	136	34	10	230	46	8	420	42	4	940	47	2
33	66	1	14	74	37	...	20	140	28	8	232	58	10	424	53	5	960	24	1
34	34	1	6	75	30	...	16	144	54	15	235	47	8	430	43	4	980	49	2
35	28	1	4	76	38	...	20	145	58	16	236	59	10	432	54	5	1000	25	1
36	54	1	6	78	39	...	20				240	24	4	440	66	6			
											245	49	8	456	57	5			

STANDARD INDEX TABLES

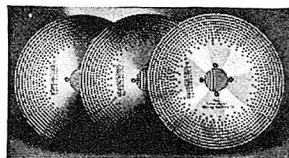
INDEX TABLE (Numerical Divisions)

FOR HIGH NUMBER INDEX PLATES

Indexes all numbers up to and including 200; all even numbers and those divisible by 5 up to and including 400, except 225, 275, 325, 375.

This accessory consists of a set of 3 index plates which are drilled on six sides. A, B, C, D, E and F. Example to index 35 divisions—This division can be made from side F, D, A, or E. The preferred side is F, since this requires the least number of holes. But should either D, A or E be in place, it can be used, thus avoiding the bother of changing plates.

No. of Div.	Side	Circle	Turns	Spaces	No. of Div.	Side	Circle	Turns	Spaces	No. of Div.	Side	Circle	Spaces	No. of Div.	Side	Circle	Spaces
2	Any	Any	20	....	19	F	38	2	4	41	C	123	120	70	D	42	24
3	A	30	13	10	19	E	133	2	14	42	E	42	40	70	A	91	52
3	B	36	13	12	19	A	171	2	18	42	A	147	140	70	E	119	68
3	E	42	13	14	20	Any	Any	2	....	43	A	129	120	71	F	71	40
3	C	93	13	31	21	E	42	1	38	44	D	44	40	72	B	36	20
3	F	159	13	53	21	A	147	1	133	44	A	99	90	72	A	117	65
4	Any	Any	10	....	22	D	44	1	36	44	F	143	130	72	C	153	85
5	Any	Any	8	....	22	A	99	1	81	45	B	36	32	73	E	73	40
6	A	30	6	20	22	F	143	1	117	45	A	99	88	74	B	111	60
6	B	36	6	24	23	C	46	1	34	45	C	153	136	75	A	30	16
6	E	42	6	28	23	A	69	1	51	46	C	46	40	76	F	38	20
6	C	93	6	62	23	E	161	1	119	46	A	69	60	76	E	133	70
6	F	159	6	106	24	A	30	1	20	46	E	161	140	76	A	171	90
7	F	28	5	20	24	B	36	1	24	47	B	141	120	77	D	77	40
7	E	42	5	30	24	E	42	1	28	48	A	30	25	78	A	117	60
7	D	77	5	55	24	C	93	1	62	48	B	36	30	79	C	79	40
7	A	91	5	65	24	F	159	1	106	49	A	147	120	80	E	26	13
8	Any	Any	5	....	25	A	30	1	18	50	A	30	24	80	F	28	14
9	B	36	4	16	25	E	175	1	105	50	E	175	140	80	A	30	15
9	A	99	4	44	26	E	26	1	14	51	C	153	120	80	D	32	16
9	C	153	4	68	26	A	91	1	49	52	E	26	20	80	C	34	17
10	Any	Any	4	....	26	B	169	1	91	52	A	91	70	80	B	36	18
11	D	44	3	28	27	B	81	1	39	52	F	143	110	80	E	42	21
11	A	99	3	63	27	A	189	1	91	52	B	169	130	81	B	81	40
11	F	143	3	91	28	F	28	1	12	53	F	159	120	82	C	123	60
12	A	30	3	10	28	E	42	1	18	54	B	81	60	83	F	83	40
12	B	36	3	12	28	D	77	1	33	54	A	189	140	84	E	42	20
12	E	42	3	14	28	A	91	1	39	55	D	44	32	84	A	147	70
12	C	93	3	31	29	E	87	1	33	55	F	143	104	85	C	34	16
12	F	159	3	53	30	A	30	1	10	56	F	28	20	85	E	119	56
13	E	26	3	2	30	B	36	1	12	56	E	42	30	85	F	187	88
13	A	91	3	7	30	E	42	1	14	56	D	77	55	86	A	129	60
13	F	143	3	11	30	C	93	1	31	56	A	91	65	87	E	87	40
13	B	169	3	13	30	F	159	1	53	57	A	171	120	88	D	44	20
14	F	28	2	24	31	C	93	1	27	58	E	87	60	88	A	99	45
14	E	42	2	36	32	F	28	1	7	59	A	177	120	88	F	143	65
14	D	77	2	66	32	D	32	1	8	60	A	30	20	89	D	89	40
14	A	91	2	78	32	B	36	1	9	60	B	36	24	90	B	36	16
15	A	30	2	20	32	A	48	1	12	60	E	42	28	90	A	99	44
15	B	36	2	24	33	A	99	1	21	60	F	159	106	90	C	153	68
15	E	42	2	28	34	C	34	1	6	61	B	183	120	91	A	91	40
15	C	93	2	62	34	E	119	1	21	62	C	93	60	92	C	46	20
15	F	159	2	106	34	F	187	1	33	63	A	189	120	92	A	69	30
16	E	26	2	13	35	F	28	1	4	64	D	32	20	92	E	161	70
16	F	28	2	14	35	D	77	1	11	64	A	48	30	93	C	93	40
16	A	30	2	15	35	A	91	1	13	65	E	26	16	94	B	141	60
16	D	32	2	16	35	E	119	1	17	65	A	91	56	95	F	38	16
16	C	34	2	17	36	B	36	1	4	65	F	143	88	95	E	133	56
16	B	36	2	18	36	A	99	1	11	65	B	169	104	95	A	171	72
17	C	34	2	12	36	C	153	1	17	66	A	99	60	96	B	36	15
17	E	119	2	42	37	B	111	1	9	67	B	67	40	96	A	48	20
17	C	153	2	54	38	F	38	1	2	68	C	34	20	97	B	97	40
17	F	187	2	66	38	E	133	1	7	68	E	119	70	98	A	147	60
18	B	36	2	8	38	A	171	1	9	68	F	187	110	99	A	99	40
18	A	99	2	22	39	A	117	1	3	69	A	69	40	100	A	30	12
18	C	153	2	34	40	Any	Any	1	....	70	F	28	16	100	E	175	70



INDEX TABLE—(Concluded)

FOR HIGH NUMBER INDEX PLATES

Fig. 106A . . . The High Number Index Plate is used by replacing the standard index plate with the High Number Plate which will give you the number of divisions required.

No. of Div.	Side	Circle	Spaces	No. of Div.	Side	Circle	Spaces	No. of Div.	Side	Circle	Spaces	No. of Div.	Side	Circle	Spaces	No. of Div.	Side	Circle	Spaces
101	F	101	40	137	D	137	40	180	C	153	34	240	E	42	7	320	A	48	6
102	C	153	60	138	A	69	20	181	C	181	40	240	A	48	8	322	E	161	20
103	E	103	40	139	C	139	40	182	A	91	20	242	D	121	20	324	B	81	10
104	E	26	10	140	F	28	8	183	B	183	40	244	B	183	30	326	D	163	20
104	A	91	35	140	E	42	12	184	C	46	10	245	A	147	24	328	C	123	15
104	F	143	55	140	D	77	22	184	A	69	15	246	C	123	20	330	A	99	12
104	B	169	65	140	A	91	26	184	E	161	35	248	C	93	15	332	F	83	10
105	E	42	16	141	B	141	40	185	B	111	24	250	E	175	28	334	C	167	20
105	A	147	56	142	F	71	20	186	C	93	20	252	A	189	30	335	B	67	8
106	F	159	60	143	F	143	40	187	F	187	40	254	B	127	20	336	E	42	5
107	D	107	40	144	B	36	10	188	B	141	30	255	C	153	24	338	B	169	20
108	B	81	30	145	E	87	24	189	A	189	40	256	D	32	5	340	C	34	4
108	A	189	70	146	E	73	20	190	F	38	8	258	A	129	20	340	E	119	14
109	C	109	40	147	A	147	40	190	E	133	28	260	E	26	4	340	F	187	22
110	D	44	16	148	B	111	30	190	A	171	36	260	A	91	14	342	A	171	20
110	A	99	36	149	E	149	40	191	E	191	40	260	F	143	22	344	A	129	15
100	F	143	52	150	A	30	8	192	A	48	10	260	B	169	26	345	A	69	8
111	B	111	40	151	D	151	40	193	D	193	40	262	F	131	20	346	F	173	20
112	F	28	10	152	F	38	10	194	B	97	20	264	A	99	15	348	E	87	10
112	E	42	15	152	E	133	35	195	A	117	24	265	F	159	24	350	E	175	20
113	F	113	40	152	A	171	45	196	A	147	30	266	E	133	20	352	D	44	5
114	A	171	60	153	C	153	40	197	C	197	40	268	B	67	10	354	A	177	20
115	C	46	16	154	D	77	20	198	A	99	20	270	B	81	12	355	F	71	8
115	A	69	24	155	C	93	24	199	B	199	40	270	A	189	28	356	D	89	10
115	E	161	56	156	A	117	30	200	A	30	6	272	C	34	5	358	D	179	20
116	E	87	30	157	B	157	40	200	E	175	35	274	D	137	20	360	B	36	4
117	A	117	40	158	C	79	20	202	F	101	20	276	A	69	10	360	A	99	11
118	A	177	60	159	F	159	40	204	C	153	30	278	C	139	20	360	C	153	17
119	E	119	40	160	F	28	7	205	C	123	24	280	F	28	4	362	C	181	20
120	A	30	10	160	D	32	8	206	E	103	20	280	E	42	6	364	A	91	10
120	B	36	12	160	B	36	9	208	E	26	5	280	D	77	11	365	E	73	8
120	E	42	14	160	A	48	12	210	E	42	8	280	A	91	13	366	B	183	20
120	C	93	31	161	E	161	40	210	A	147	28	282	B	141	20	368	C	46	5
120	F	159	53	162	B	81	20	212	F	159	30	284	F	71	10	370	B	111	12
121	D	121	40	163	D	163	40	214	D	107	20	285	A	171	24	372	C	93	10
122	B	183	60	164	C	123	30	215	A	129	24	286	F	143	20	374	F	187	20
123	C	123	40	165	A	99	24	216	B	81	15	288	B	36	5	376	B	141	15
124	C	93	30	166	F	83	20	216	A	189	35	290	E	87	12	378	A	189	20
125	E	175	56	167	C	167	40	218	C	109	20	292	E	73	10	380	F	38	4
126	A	189	60	168	E	42	10	220	D	44	8	294	A	147	20	380	E	133	14
127	B	127	40	168	A	147	35	220	A	99	18	295	A	177	24	380	A	171	18
128	D	32	10	169	B	169	40	220	F	143	26	296	B	111	15	382	E	191	20
128	A	48	15	170	C	34	8	222	B	111	20	298	E	149	20	384	A	48	5
129	A	129	40	170	E	119	28	224	F	28	5	300	A	30	4	385	D	77	8
130	E	26	8	170	F	187	44	226	F	113	20	302	D	151	20	386	D	193	20
130	A	91	28	171	A	171	40	228	A	171	30	304	F	38	5	388	B	97	10
130	F	143	44	172	A	129	30	230	C	46	8	305	B	183	24	390	A	117	12
130	B	169	52	173	F	173	40	230	A	69	12	306	C	153	20	392	A	147	15
131	F	131	40	174	E	87	20	230	E	161	28	308	D	77	10	394	C	197	20
132	A	99	30	175	E	175	40	232	E	87	15	310	C	93	12	395	C	79	8
133	E	133	40	176	D	44	10	234	A	117	20	312	A	117	15	396	A	99	10
134	B	67	20	177	A	177	40	235	B	141	24	314	B	157	20	398	B	199	20
135	B	81	24	178	D	89	20	236	A	177	30	315	A	189	24	400	A	30	3
135	A	189	56	179	D	179	40	238	E	119	20	316	C	79	10	.....	.....	.....	.....
136	C	34	10	180	B	36	8	240	A	30	5	318	F	159	20	.....	.....	.....	.....
136	E	119	35	180	A	99	22	240	B	36	6	320	D	32	4	.....	.....	.....	.....

TABLE OF ANGULAR DIVISIONS
Obtainable With Standard Dividing Head and Wide Range Divider
(Use 54-hole circle on large plate)

DEGREES

Degrees	Turns of Crank B	Spaces B	Degrees	Turns of Crank B	Spaces B	Degrees	Turns of Crank B	Spaces B	Degrees	Turns of Crank B	Spaces B	Degrees	Turns of Crank B	Spaces B	Degrees	Turns of Crank B	Spaces B	Degrees	Turns of Crank B	Spaces B	Degrees	Turns of Crank B	Spaces B
1	6	30	181	17	48	201	22	18	241	26	42	281	31	12	321	35	96	321	35	96	321	35	96
2	12	36	182	18	6	202	22	24	242	27	48	282	31	18	322	35	42	322	35	42	322	35	42
3	18	42	183	18	12	203	22	30	243	27	6	283	31	24	323	35	48	323	35	48	323	35	48
4	24	48	184	18	18	204	22	36	244	27	12	284	31	30	324	35	12	324	35	12	324	35	12
5	30	54	185	18	24	205	22	42	245	27	18	285	31	36	325	35	18	325	35	18	325	35	18
6	36	60	186	18	30	206	22	48	246	27	24	286	31	42	326	35	24	326	35	24	326	35	24
7	42	66	187	18	36	207	22	54	247	27	30	287	31	48	327	35	30	327	35	30	327	35	30
8	48	72	188	18	42	208	22	60	248	27	36	288	31	54	328	35	36	328	35	36	328	35	36
9	54	78	189	18	48	209	22	66	249	27	42	289	31	60	329	35	42	329	35	42	329	35	42
10	60	84	190	18	54	210	22	72	250	27	48	290	31	66	330	35	48	330	35	48	330	35	48
11	66	90	191	18	60	211	22	78	251	27	54	291	31	72	331	35	54	331	35	54	331	35	54
12	72	96	192	18	66	212	22	84	252	27	60	292	31	78	332	35	60	332	35	60	332	35	60
13	78	102	193	18	72	213	22	90	253	27	66	293	31	84	333	35	66	333	35	66	333	35	66
14	84	108	194	18	78	214	22	96	254	27	72	294	31	90	334	35	72	334	35	72	334	35	72
15	90	114	195	18	84	215	22	102	255	27	78	295	31	96	335	35	78	335	35	78	335	35	78
16	96	120	196	18	90	216	22	108	256	27	84	296	31	102	336	35	84	336	35	84	336	35	84
17	102	126	197	18	96	217	22	114	257	27	90	297	31	108	337	35	90	337	35	90	337	35	90
18	108	132	198	18	102	218	22	120	258	27	96	298	31	114	338	35	96	338	35	96	338	35	96
19	114	138	199	18	108	219	22	126	259	27	102	299	31	120	339	35	102	339	35	102	339	35	102
20	120	144	200	18	114	220	22	132	260	27	108	300	31	126	340	35	108	340	35	108	340	35	108
21	126	150	201	18	120	221	22	138	261	27	114	301	31	132	341	35	114	341	35	114	341	35	114
22	132	156	202	18	126	222	22	144	262	27	120	302	31	138	342	35	120	342	35	120	342	35	120
23	138	162	203	18	132	223	22	150	263	27	126	303	31	144	343	35	126	343	35	126	343	35	126
24	144	168	204	18	138	224	22	156	264	27	132	304	31	150	344	35	132	344	35	132	344	35	132
25	150	174	205	18	144	225	22	162	265	27	138	305	31	156	345	35	138	345	35	138	345	35	138
26	156	180	206	18	150	226	22	168	266	27	144	306	31	162	346	35	144	346	35	144	346	35	144
27	162	186	207	18	156	227	22	174	267	27	150	307	31	168	347	35	150	347	35	150	347	35	150
28	168	192	208	18	162	228	22	180	268	27	156	308	31	174	348	35	156	348	35	156	348	35	156
29	174	198	209	18	168	229	22	186	269	27	162	309	31	180	349	35	162	349	35	162	349	35	162
30	180	204	210	18	174	230	22	192	270	27	168	310	31	186	350	35	168	350	35	168	350	35	168
31	186	210	211	18	180	231	22	198	271	27	174	311	31	192	351	35	174	351	35	174	351	35	174
32	192	216	212	18	186	232	22	204	272	27	180	312	31	198	352	35	180	352	35	180	352	35	180
33	198	222	213	18	192	233	22	210	273	27	186	313	31	204	353	35	186	353	35	186	353	35	186
34	204	228	214	18	198	234	22	216	274	27	192	314	31	210	354	35	192	354	35	192	354	35	192
35	210	234	215	18	204	235	22	222	275	27	198	315	31	216	355	35	198	355	35	198	355	35	198
36	216	240	216	18	210	236	22	228	276	27	204	316	31	222	356	35	204	356	35	204	356	35	204
37	222	246	217	18	216	237	22	234	277	27	210	317	31	228	357	35	210	357	35	210	357	35	210
38	228	252	218	18	222	238	22	240	278	27	216	318	31	234	358	35	216	358	35	216	358	35	216
39	234	258	219	18	228	239	22	246	279	27	222	319	31	240	359	35	222	359	35	222	359	35	222
40	240	264	220	18	234	240	22	252	280	27	228	320	31	246	360	35	228	360	35	228	360	35	228

TABLE OF ANGULAR DIVISIONS . . . Obtainable With Wide Range Divider

(Use 54-hole circle on small plate)

FRACTIONS OF A DEGREE

Minutes	Seconds	Turns of Crank D	Spaces Crank D	Minutes	Seconds	Turns of Crank D	Spaces Crank D	Minutes	Seconds	Turns of Crank D	Spaces Crank D	Minutes	Seconds	Turns of Crank D	Spaces Crank D	Minutes	Seconds	Turns of Crank D	Spaces Crank D	Minutes	Seconds	Turns of Crank D	Spaces Crank D	Minutes	Seconds	Turns of Crank D	Spaces Crank D	Minutes	Seconds	Turns of Crank D	Spaces Crank D
0	6	1	1	8	12	1	28	16	12	2	52	24	12	4	24	32	12	5	50	40	7	22	48	56	12	8	8	10	20		
0	12	2	1	16	24	3	30	32	24	4	26	24	24	4	28	32	24	6	52	48	7	24	48	56	24	16	10	22			
0	18	3	1	24	36	4	32	48	36	6	30	32	36	6	32	32	36	6	56	52	7	26	48	56	36	10	24				
0	24	4	1	32	48	5	34	48	48	6	34	32	48	6	36	32	48	6	56	52	7	28	48	56	48	10	26				
0	30	5	1	40	54	6	36	48	54	6	36	32	48	6	38	32	48	6	56	52	7	30	48	56	54	10	28				
0	36	6	1	48	54	7	38	48	54	6	38	32	48	6	40	32	48	6	56	52	7	32	48	56	54	10	30				
0	42	7	1	56	54	8	40	48	54	6	40	32	48	6	42	32	48	6	56	52	7	34	48	56	54	10	32				
0	48	8	1	64	54	9	42	48	54	6	42	32	48	6	44	32	48	6	56	52	7	36	48	56	54	10	34				
1	0	9	1	72	54	10	44	48	54	6	44	32	48	6	46	32	48	6	56	52	7	38	48	56	54	10	36				
1	6	10	1	80	54	11	46	48	54	6	46	32	48	6	48	32	48	6	56	52	7	40	48	56	54	10	38				
1	12	11	1	88	54	12	48	48	54	6	48	32	48	6	50	32	48	6	56	52	7	42	48	56	54	10	40				
1	18	12	1	96	54	13	50	48	54	6	50	32	48	6	52	32	48	6	56	52	7	44	48	56	54	10	42				
1	24	13	1	104	54	14	52	48	54	6	52	32	48	6	54	32	48	6	56	52	7	46	48	56	54	10	44				
1	30	14	1	112	54	15	54	48	54	6	54	32	48	6	56	32	48	6	56	52	7	48	48	56	54	10	46				
1	36	15	1	120	54	16	56	48	54	6	56	32	48	6	58	32	48	6	56	52	7	50	48	56	54	10	48				
1	42	16	1	128	54	17	58	48	54	6	58	32	48	6	60	32	48	6	56	52	7	52	48	56	54	10	50				
1	48	17	1	136	54	18	60	48	54	6	60	32	48	6	62	32	48	6	56	52	7	54	48	56	54	10	52				
2	0	18	1	144	54	19	62	48	54	6	62	32	48	6	64	32	48	6	56	52	7	56	48	56	54	10	54				
2	6	19	1	152	54	20	64	48	54	6	64	32	48	6	66	32	48	6	56	52	7	58	48	56	54	10	56				
2	12	20	1	160	54	21	66	48	54	6	66	32	48	6	68	32	48	6	56	52	7	60	48	56	54	10	58				
2	18	21	1	168	54	22	68	48	54	6	68	32	48	6	70	32	48	6	56	52	7	62	48	56	54	10	60				
2	24	22	1	176	54	23	70	48	54	6	70	32	48	6	72	32	48	6	56	52	7	64	48	56	54	10	62				
2	30	23	1	184	54	24	72	48	54	6	72	32	48	6	74	32	48	6	56	52	7	66	48	56	54	10	64				
2	36	24	1	192	54	25	74	48	54	6	74	32	48	6	76	32	48	6	56	52	7	68	48	56	54	10	66				
2	42	25	1	200	54	26	76	48	54	6	76	32	48	6	78	32	48	6	56	52	7	70	48	56	54	10	68				
2	48	26	1	208	54	27	78	48	54	6	78	32	48	6	80	32	48	6	56	52	7	72	48	56	54	10	70				
3	0	27	1	216	54	28	80	48	54	6	80	32	48	6	82	32	48	6	56	52	7	74	48	56	54	10	72				
3	6	28	1	224	54	29	82	48	54	6	82	32	48	6	84	32	48	6	56	52	7	76	48	56	54	10	74				
3	12	29	1	232	54	30	84	48	54	6	84	32	48	6	86	32	48	6	56	52	7	78	48	56	54	10	76				
3	18	30	1	240	54	31	86	48	54	6	86	32	48	6	88	32	48	6	56	52	7	80	48	56	54	10	78				
3	24	31	1	248	54	32	88	48	54	6	88	32	48	6	90	32	48	6	56	52	7	82	48	56	54	10	80				
3	30	32	1	256	54	33	90	48	54	6	90	32	48	6	92	32	48	6	56	52	7	84	48	56	54	10	82				
3	36	33	1	264	54	34	92	48	54	6	92	32	48	6	94	32	48	6	56	52	7	86	48	56	54	10	84				
3	42	34	1	272	54	35	94	48	54	6	94	32	48	6	96	32	48	6	56	52	7	88	48	56	54	10	86				
3	48	35	1	280	54	36	96	48	54	6	96	32	48	6	98	32	48	6	56	52	7	90	48	56	54	10	88				
4	0	36	1	288	54	37	98	48	54	6	98	32	48	6	100	32	48	6	56	52	7	92	48	56	54	10	90				
4	6	37	1	296	54	38	100	48	54	6	100	32	48	6	102	32	48	6	56	52	7	94	48	56	54	10	92				
4	12	38	1	304	54	39	102	48	54	6	102	32	48	6	104	32	48	6	56	52	7	96	48	56	54	10	94				
4	18	39	1	312	54	40	104	48	54	6	104	32	48	6	106	32	48	6	56	52	7	98	48	56	54	10	96				
4	24	40	1	320	54	41	106	48	54	6	106	32	48	6	108	32	48	6	56	52	7	100	48	56	54	10	98				
4	30	41	1	328	54	42	108	48	54	6	108	32	48	6	110	32	48	6	56	52	7	102	48	56	54	10	100				
4	36	42	1	336	54	43	110	48	54	6	110	32	48	6	112	32	48	6	56	52	7	104	48	56	54	10	102				
4	42	43	1	344	54	44	112	48	54	6	112	32	48	6	114	32	48	6	56	52	7	106	48	56	54	10	104				
4	48	44	1	352	54	45	114	48	54	6	114	32	48	6	116	32	48	6	56	52	7	108	48	56	54	10	106				
5	0	45	1	360	54	46	116	48	54	6	116	32	48	6	118	32	48	6	56	52	7	110	48	56	54	10	108				
5	6	46	1	368	54	47	118	48	54	6	118	32	48	6	120	32	48	6	56	52	7	112	48	56	54	10	110				
5	12	47	1	376	54	48	120	48	54	6	120	32	48	6	122	32	48	6	56	52	7	114	48	56	54	10	112				
5	18	48	1	384	54	49	122	48	54	6	122	32	48	6	124	32	48	6	56	52	7	116	48	56	54	10	114				
5	24	49	1	392	54	50	124	48	54	6	124	32	48	6	126	32	48	6	56	52	7	118	48	56	54	10	116				
5	30	50	1	400	54	51	126	48	54	6	126	32	48	6	128	32	48	6	56	52	7	120	48	56	54	10	118				
5	36	51	1	408	54	52	128	48	54	6	128	32	48	6	130	32	48	6	56	52	7	122	48	56	54	10	120				
5	42	52	1	416	54	53	130	48	54	6	130	32	48	6	132	32	48	6	56	52	7	124	48	56	54	10	122				
5	48	53	1	424	54	54	132	48	54	6	132	32	48	6	134	32	48	6	56	52	7	126	48	56	54	10	124				
6	0	54	1	432	54	55	134	48	54	6	134	32	48	6	136	32	48	6	56	52	7	128	48	56	54	10	126				
6	6	55	1	440	54	56	136	48	54	6	136	32	48	6	138	32	48	6	56	52	7	130	48	56	54	10	128				
6	12	56	1	448	54	57	138	48	54	6	138	32	48	6	140	32	48	6	56	52	7	132	48	56	54	10	130				
6	18	57	1	456	54	58	140	48	54	6	140	32	48	6	142	32	48	6	56	52	7	134	48	56	54	10	132				
6	24	58	1	464	54	59	142	48	54	6	142	32	48	6	144	32	48	6	56	52	7	136	48	56	54	10	134				
6	30	59	1	472	54	60	144	48	54	6	144	32	48	6	146	32	48	6	56	52	7	138	48	56	54	10	136				
6	36	60	1	480	54	61	146	48	54	6	146	32	48	6	148	32	48	6	56	52	7	140	48	56	54	10	138				
6	42	61	1	488	54	62	148	48	54	6																					

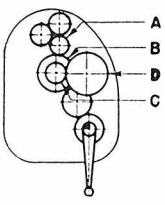
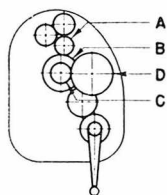


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (2.500 to 3.800)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
2.500	27	45	20	48	2.923	19	39	27	45	3.385	22	39	27	45
2.507	22	39	20	45	2.927	19	51	33	42	3.389	22	42	33	51
2.510	24	45	24	51	2.930	20	39	24	42	3.394	21	33	24	45
2.513	19	36	20	42	2.941	24	51	30	48	3.399	39	45	20	51
2.516	21	36	22	51	2.946	22	42	27	48	3.409	27	33	20	48
2.521	20	42	27	51	2.956	21	30	19	45	3.415	33	36	19	51
2.530	17	42	30	48	2.966	22	51	33	48	3.422	24	33	24	51
2.534	21	39	24	51	2.976	20	48	30	42	3.429	24	42	27	45
2.540	20	42	24	45	2.986	22	39	27	51	3.437	27	36	22	48
2.546	22	36	20	48	2.991	20	36	21	39	3.440	22	27	19	45
2.552	22	39	19	42	2.995	21	33	24	51	3.451	24	30	22	51
2.561	19	51	33	48	3.000	21	55	33	42	3.457	21	27	20	45
2.567	24	33	18	51	3.009	22	45	24	39	3.462	27	39	24	48
2.574	21	48	30	51	3.017	20	51	30	39	3.472	30	36	20	48
2.579	19	39	27	51	3.025	24	42	27	51	3.480	30	39	19	42
2.588	22	51	27	45	3.029	21	39	27	48	3.486	24	27	20	51
2.593	21	36	20	45	3.039	18	55	39	42	3.492	30	42	22	45
2.598	24	39	19	45	3.048	24	42	24	45	3.500	36	45	21	48
2.608	21	30	19	51	3.056	22	45	30	48	3.505	39	48	22	51
2.614	20	51	30	45	3.068	27	33	18	48	3.516	24	39	24	42
2.619	22	42	24	48	3.077	20	39	27	45	3.526	30	39	22	48
2.625	21	45	27	48	3.081	22	51	30	42	3.535	21	33	20	36
2.632	21	39	22	45	3.088	21	51	36	48	3.543	24	33	19	39
2.639	19	45	30	48	3.096	22	30	19	45	3.556	24	36	24	45
2.647	24	48	27	51	3.105	30	36	19	51	3.565	30	33	20	51
2.655	22	39	24	51	3.111	24	36	21	45	3.571	30	42	24	48
2.661	19	51	30	42	3.117	24	33	18	42	3.580	27	33	21	48
2.667	24	45	24	48	3.125	21	42	30	48	3.590	42	39	17	51
2.674	21	36	22	48	3.134	20	36	22	39	3.595	30	36	22	51
2.679	20	42	27	48	3.143	22	42	27	45	3.603	21	48	42	51
2.689	24	42	24	51	3.152	19	51	33	39	3.611	39	36	17	51
2.696	22	51	30	48	3.163	22	45	33	51	3.620	30	39	24	51
2.707	20	36	19	39	3.173	27	39	22	48	3.626	27	39	22	42
2.715	20	39	27	51	3.182	24	33	21	48	3.636	24	33	24	48
2.727	21	33	18	42	3.189	19	55	36	39	3.641	39	42	20	51
2.735	24	39	20	45	3.199	20	33	19	36	3.650	33	39	22	51
2.745	24	36	21	51	3.205	20	39	30	48	3.660	24	27	21	51
2.750	22	45	27	48	3.214	24	48	27	42	3.667	24	30	22	48
2.764	19	55	36	45	3.223	22	39	24	42	3.676	39	42	19	48
2.773	22	42	27	51	3.231	27	39	21	45	3.686	22	27	19	42
2.778	20	45	30	48	3.239	27	33	19	48	3.692	27	39	24	45
2.784	24	39	19	42	3.248	19	45	30	39	3.697	33	42	24	51
2.794	22	42	24	45	3.258	27	39	24	51	3.702	33	39	21	48
2.801	20	42	30	51	3.263	21	33	20	39	3.706	27	30	21	51
2.812	21	42	27	48	3.268	30	36	20	51	3.714	39	42	18	45
2.820	22	39	24	48	3.274	22	48	30	42	3.720	19	55	42	39
2.824	24	51	27	45	3.282	24	39	24	45	3.730	24	33	20	39
2.831	21	51	33	48	3.284	21	27	19	45	3.739	22	51	39	45
2.842	19	36	21	39	3.291	21	39	22	36	3.743	30	33	21	51
2.851	21	39	27	51	3.297	20	39	27	42	3.750	18	45	48	48
2.857	24	42	24	48	3.309	27	48	30	51	3.753	24	27	19	45
2.866	19	39	30	51	3.318	22	51	30	39	3.761	30	39	22	45
2.876	22	51	30	45	3.329	17	55	42	39	3.765	24	30	24	51
2.879	24	33	19	48	3.333	21	42	30	45	3.770	30	36	19	42
2.885	20	39	27	48	3.346	21	51	39	48	3.775	33	36	21	51
2.896	24	39	24	51	3.353	27	30	19	51	3.782	30	42	27	51
2.903	19	45	33	48	3.361	22	45	33	48	3.788	30	33	20	48
2.910	20	36	22	42	3.369	27	33	21	51	3.792	39	45	21	48
2.917	21	45	30	48	3.377	20	55	39	42	3.800	27	30	19	45



CINCINNATI DIAL TYPE MILLING MACHINES

TABLE OF LEADS (3.810 to 5.025)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
3.810	30	42	24	45	4.202	45	42	20	51	4.606	36	33	19	45
3.818	27	33	21	45	4.215	17	55	45	33	4.615	18	42	..	39
3.824	39	42	21	51	4.222	19	42	..	45	4.622	33	42	30	51
3.828	33	39	19	42	4.231	33	39	24	48	4.628	20	55	42	33
3.834	24	27	22	51	4.235	27	30	24	51	4.635	39	33	20	51
3.838	30	33	19	45	4.242	30	33	21	45	4.643	39	42	24	48
3.843	21	51	42	45	4.248	39	36	20	51	4.646	42	39	22	51
3.850	27	33	24	51	4.256	39	42	22	48	4.656	24	27	22	42
3.860	21	51	45	48	4.263	42	39	19	48	4.662	30	33	20	39
3.869	39	42	20	48	4.267	24	30	24	45	4.667	21	39	..	45
3.878	33	39	22	48	4.274	30	36	20	39	4.673	39	36	22	51
3.882	27	30	22	51	4.278	33	36	21	45	4.678	39	33	19	48
3.889	30	36	21	45	4.286	18	45	..	42	4.687	30	36	27	48
3.897	36	39	19	45	4.293	30	33	17	36	4.691	30	27	19	45
3.911	24	30	22	45	4.299	45	39	19	51	4.701	30	36	22	39
3.916	24	33	21	39	4.308	36	39	21	45	4.706	24	36	..	51
3.922	20	48	..	51	4.314	22	45	..	51	4.711	19	55	45	33
3.929	33	42	24	48	4.318	36	33	19	48	4.714	33	42	27	45
3.937	27	30	21	48	4.327	30	39	27	48	4.722	17	42	..	36
3.949	33	39	21	45	4.333	39	45	24	48	4.727	39	33	18	45
3.954	33	36	22	51	4.344	36	39	24	51	4.740	39	36	21	48
3.958	19	45	..	48	4.354	33	30	19	48	4.745	33	30	22	51
3.963	30	33	17	39	4.364	27	33	24	45	4.751	21	51	45	39
3.968	30	36	20	42	4.370	24	42	39	51	4.762	20	39	..	42
3.972	39	45	22	48	4.375	21	45	..	48	4.773	36	33	21	48
3.977	30	33	21	48	4.387	22	27	21	39	4.777	17	55	51	33
3.982	33	39	24	51	4.392	24	45	42	51	4.786	42	39	20	45
3.986	27	33	19	39	4.396	30	39	24	42	4.793	30	27	22	51
3.992	45	42	19	51	4.400	27	30	22	45	4.800	27	30	24	45
4.000	27	36	24	45	4.406	27	33	21	39	4.807	19	48	51	42
4.006	39	42	22	51	4.412	30	36	27	51	4.813	30	33	27	51
4.011	33	36	21	48	4.420	33	42	27	48	4.821	36	42	27	48
4.018	30	42	27	48	4.429	30	33	19	39	4.827	48	39	20	51
4.021	24	27	19	42	4.434	42	39	21	51	4.835	33	39	24	42
4.029	30	39	22	42	4.444	20	42	..	45	4.843	39	30	19	51
4.034	36	42	24	51	4.453	27	24	19	48	4.848	30	33	24	45
4.040	30	33	20	45	4.461	39	36	21	51	4.853	33	36	27	51
4.048	17	39	..	42	4.466	33	36	19	39	4.858	27	22	19	48
4.060	30	36	19	39	4.471	36	30	19	51	4.866	39	33	21	51
4.064	36	33	19	51	4.476	24	33	24	39	4.875	39	30	18	48
4.072	30	39	27	51	4.480	33	39	27	51	4.887	36	39	27	51
4.078	24	45	39	51	4.486	19	48	51	45	4.895	30	33	21	39
4.083	21	48	42	45	4.492	36	33	21	51	4.902	45	36	20	51
4.091	27	33	21	42	4.500	27	30	24	48	4.911	33	42	30	48
4.098	33	30	19	51	4.508	42	33	17	48	4.916	27	42	39	51
4.103	30	39	24	45	4.514	39	36	20	48	4.922	27	24	21	48
4.113	30	33	19	42	4.524	19	45	..	42	4.926	42	36	19	45
4.118	21	48	..	51	4.529	33	30	21	51	4.935	36	33	19	42
4.125	33	45	27	48	4.533	36	30	17	45	4.941	36	30	21	51
4.136	21	55	39	36	4.540	39	42	22	45	4.945	30	39	27	42
4.147	33	36	19	42	4.547	42	39	19	45	4.948	45	36	19	48
4.156	24	33	24	42	4.553	33	27	19	51	4.952	39	42	24	45
4.160	33	42	27	51	4.558	24	27	20	39	4.959	20	55	45	33
4.167	20	39	..	48	4.567	45	39	19	48	4.967	48	36	19	51
4.171	39	33	18	51	4.571	36	42	24	45	4.977	33	39	30	51
4.176	36	39	19	42	4.575	42	36	20	51	4.990	39	33	19	45
4.183	20	51	48	45	4.583	22	39	..	48	5.000	24	36	..	48
4.190	33	42	24	45	4.588	39	30	18	51	5.014	24	27	22	39
4.196	27	33	20	39	4.602	27	22	18	48	5.025	19	55	48	33

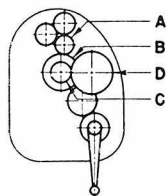
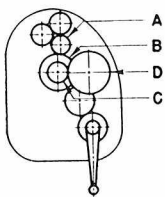


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (5.033 to 6.291)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
5.033	42	36	22	51	5.440	33	39	27	42	5.882	30	36	..	51
5.038	42	33	19	48	5.444	42	36	21	45	5.887	48	33	17	42
5.042	33	30	22	48	5.455	36	33	24	48	5.893	33	36	27	42
5.048	45	39	21	48	5.469	45	36	21	48	5.903	55	33	17	48
5.056	39	36	21	45	5.481	27	24	19	39	5.911	42	30	19	45
5.065	39	33	18	42	5.489	39	30	19	45	5.921	30	19	18	48
5.068	21	51	48	39	5.495	45	39	20	42	5.926	24	27	24	36
5.077	33	39	27	45	5.500	33	36	27	45	5.934	36	39	27	42
5.080	45	33	19	51	5.510	27	21	18	42	5.939	42	33	21	45
5.085	42	36	17	39	5.515	39	33	21	45	5.948	39	27	21	51
5.091	36	33	21	45	5.527	19	55	48	30	5.954	33	27	19	39
5.098	39	36	24	51	5.538	36	39	27	45	5.961	48	30	19	51
5.104	42	36	21	48	5.546	33	21	18	51	5.966	45	33	21	48
5.114	30	33	27	48	5.552	27	22	19	42	5.975	33	27	22	45
5.123	33	24	19	51	5.556	20	39	..	36	5.983	42	36	20	39
5.128	20	42	..	39	5.561	39	33	24	51	5.989	42	33	24	51
5.135	20	51	55	42	5.568	42	33	21	48	5.994	51	39	22	48
5.143	36	42	27	45	5.573	30	19	18	51	6.000	27	39	..	45
5.147	45	36	21	51	5.581	39	33	17	36	6.010	42	33	17	36
5.152	17	45	..	33	5.587	22	45	48	42	6.019	39	27	20	48
5.156	33	36	27	48	5.594	30	33	24	39	6.027	27	42	45	48
5.160	33	27	19	45	5.600	36	30	21	45	6.032	48	36	19	42
5.170	39	33	21	48	5.608	39	30	22	51	6.039	42	30	22	51
5.176	51	39	19	48	5.615	45	33	21	51	6.044	33	39	30	42
5.185	42	36	20	45	5.625	27	36	..	48	6.050	36	21	18	51
5.192	36	39	27	48	5.630	48	36	19	45	6.054	39	24	19	51
5.195	30	33	24	42	5.641	22	42	..	39	6.058	27	24	21	39
5.200	39	30	18	45	5.647	36	30	24	51	6.061	20	42	..	33
5.208	45	36	20	48	5.657	42	33	20	45	6.067	39	30	21	45
5.216	42	30	19	51	5.664	39	27	20	51	6.071	45	30	17	42
5.223	27	48	39	42	5.675	39	36	22	42	6.090	45	36	19	39
5.229	48	36	20	51	5.682	45	33	20	48	6.095	24	45	48	42
5.238	22	45	..	42	5.687	39	30	21	48	6.100	42	27	20	51
5.241	42	33	21	51	5.692	55	36	19	51	6.107	27	20	19	42
5.250	27	30	21	36	5.698	30	27	20	39	6.111	22	42	..	36
5.255	17	55	51	30	5.704	42	36	22	45	6.118	39	30	24	51
5.260	27	22	18	42	5.714	24	39	..	42	6.125	42	30	21	48
5.265	42	39	22	45	5.718	39	27	19	48	6.130	33	19	18	51
5.272	33	27	22	51	5.727	27	22	21	45	6.136	36	33	27	48
5.278	19	42	..	36	5.735	39	24	18	51	6.141	48	33	19	45
5.288	33	39	30	48	5.744	42	39	24	45	6.154	24	42	..	39
5.294	27	36	..	51	5.752	33	27	24	51	6.162	33	21	20	51
5.303	42	33	20	48	5.758	19	42	..	33	6.169	45	33	19	42
5.312	51	36	18	48	5.762	33	30	22	42	6.176	36	24	21	51
5.322	30	21	19	51	5.769	36	39	30	48	6.182	51	33	18	45
5.333	24	39	..	45	5.775	36	33	27	51	6.190	39	36	24	42
5.339	19	55	51	33	5.782	30	21	17	42	6.198	51	36	21	48
5.347	42	36	22	48	5.789	33	19	17	51	6.205	33	30	22	39
5.353	39	30	21	51	5.795	51	33	18	48	6.209	45	27	19	51
5.359	33	30	19	39	5.804	30	42	39	48	6.222	42	36	24	45
5.369	27	22	21	48	5.807	21	51	55	39	6.231	39	27	22	51
5.378	33	30	22	45	5.816	27	21	19	42	6.237	39	33	19	36
5.385	21	42	..	39	5.820	30	27	22	42	6.250	30	36	..	48
5.392	45	36	22	51	5.824	33	30	27	51	6.257	39	33	27	51
5.398	45	33	19	48	5.833	21	39	..	36	6.268	30	27	22	39
5.413	30	27	19	39	5.844	30	33	27	42	6.275	48	33	22	51
5.419	48	33	19	51	5.854	33	21	19	51	6.282	42	36	21	39
5.429	36	30	19	42	5.864	30	27	19	36	6.286	33	21	18	45
5.432	30	27	22	45	5.874	36	33	21	39	6.291	21	51	55	36



CINCINNATI DIAL TYPE MILLING MACHINES

TABLE OF LEADS (6.296 to 7.483)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
6.296	17	45	..	27	6.699	33	24	19	39	7.059	45	30	24	51
6.303	39	33	24	45	6.710	42	27	22	51	7.062	39	27	22	45
6.316	36	19	17	51	6.713	36	33	24	39	7.071	33	30	27	42
6.319	39	27	21	48	6.717	42	33	19	36	7.083	17	45	..	24
6.333	19	42	..	30	6.722	33	24	22	45	7.086	48	33	19	39
6.340	48	33	17	39	6.729	51	30	19	48	7.091	39	33	27	45
6.346	33	36	27	39	6.734	30	27	20	33	7.105	36	19	18	48
6.349	48	36	20	42	6.738	42	33	27	51	7.112	42	22	19	51
6.353	36	30	27	51	6.741	39	27	21	45	7.125	36	20	19	48
6.356	39	30	22	45	6.746	55	33	17	42	7.130	42	27	22	48
6.364	21	42	..	33	6.750	36	30	27	48	7.136	51	27	17	45
6.375	51	30	18	48	6.756	48	30	19	45	7.143	30	39	..	42
6.387	36	21	19	51	6.761	51	33	21	48	7.152	33	19	21	51
6.393	22	45	51	39	6.769	33	30	24	39	7.159	42	33	27	48
6.400	36	30	24	45	6.774	60	33	19	51	7.175	39	22	17	42
6.405	42	27	21	51	6.779	33	21	22	51	7.179	42	36	24	39
6.410	45	36	20	39	6.786	45	30	19	42	7.190	33	27	30	51
6.417	36	33	30	51	6.790	30	27	22	36	7.200	36	30	27	45
6.420	39	27	20	45	6.797	39	27	24	51	7.206	42	24	21	51
6.429	27	39	..	42	6.806	42	27	21	48	7.212	51	33	21	45
6.439	45	33	17	36	6.810	39	30	22	42	7.222	39	27	24	48
6.447	22	42	48	39	6.818	36	33	30	48	7.232	33	17	19	51
6.451	33	27	19	36	6.821	42	30	19	39	7.240	30	39	48	51
6.462	42	39	27	45	6.830	55	30	19	51	7.245	39	19	18	51
6.465	48	33	20	45	6.838	48	36	20	39	7.253	36	39	33	42
6.471	33	36	..	51	6.845	24	51	48	33	7.259	42	27	21	45
6.477	36	22	19	48	6.853	42	33	21	39	7.265	45	27	17	39
6.481	42	27	20	48	6.857	36	30	24	42	7.273	24	42	..	33
6.490	27	39	45	48	6.863	45	27	21	51	7.279	33	24	27	51
6.494	45	33	20	42	6.869	48	33	17	36	7.283	39	21	20	51
6.500	39	30	24	48	6.875	33	30	..	48	7.286	51	30	18	42
6.513	33	19	18	48	6.878	39	27	20	42	7.292	45	27	21	48
6.519	33	27	24	45	6.882	39	30	27	51	7.299	39	22	21	51
6.525	51	33	19	45	6.894	39	33	21	36	7.308	45	30	19	39
6.531	33	20	19	48	6.902	48	30	22	51	7.313	39	20	18	48
6.536	45	27	20	51	6.908	30	19	21	48	7.320	42	27	24	51
6.545	36	33	27	45	6.914	42	27	20	45	7.326	30	21	20	39
6.555	39	21	18	51	6.919	39	21	19	51	7.333	33	36	..	45
6.563	36	24	21	48	6.923	27	42	..	39	7.341	19	55	51	24
6.568	42	27	19	45	6.926	48	33	20	42	7.347	27	21	24	42
6.577	39	21	17	48	6.933	39	30	24	45	7.353	45	24	20	51
6.581	42	36	22	39	6.939	36	21	17	42	7.368	30	19	21	45
6.588	42	30	24	51	6.944	45	27	20	48	7.385	36	30	24	39
6.593	45	39	24	42	6.947	33	19	18	45	7.389	42	24	19	45
6.600	33	30	27	45	6.952	39	33	30	51	7.395	33	21	24	51
6.608	27	22	21	39	6.955	18	55	51	24	7.403	36	22	19	42
6.611	42	24	17	45	6.960	30	21	19	39	7.407	20	45	..	27
6.618	30	24	27	51	6.964	39	36	27	42	7.412	42	30	27	51
6.623	51	33	18	42	6.968	33	39	42	51	7.418	45	39	27	42
6.632	27	19	21	45	6.972	48	27	20	51	7.424	42	33	21	36
6.635	33	21	19	45	6.984	48	36	22	42	7.429	39	30	24	42
6.643	45	33	19	39	6.993	45	33	20	39	7.438	51	30	21	48
6.648	39	33	27	48	7.000	21	42	..	30	7.444	33	19	18	42
6.667	30	36	..	45	7.010	39	24	22	51	7.451	42	21	19	51
6.679	33	20	17	42	7.013	36	33	27	42	7.459	48	33	20	39
6.684	55	36	21	48	7.018	30	19	20	45	7.464	33	20	19	42
6.687	36	19	18	51	7.030	33	19	17	42	7.469	33	27	22	36
6.691	39	24	21	51	7.037	19	45	..	27	7.474	36	17	18	51
6.696	30	42	45	48	7.051	30	24	22	39	7.483	30	21	22	42

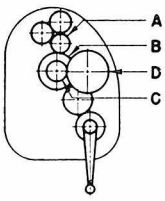
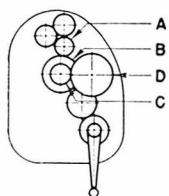


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (7.487 to 8.766)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
7.487	42	33	30	51	7.889	36	17	19	51	8.319	33	21	27	51
7.492	33	19	22	51	7.897	42	30	22	39	8.322	51	33	21	39
7.500	36	33	..	48	7.901	48	27	20	45	8.333	30	39	..	36
7.506	48	27	19	45	7.908	33	18	22	51	8.342	39	22	24	51
7.517	39	21	17	42	7.912	48	39	27	42	8.352	42	22	21	48
7.521	48	36	22	39	7.917	19	42	..	24	8.357	39	30	27	42
7.529	51	33	19	39	7.933	51	30	21	45	8.366	48	27	24	51
7.538	42	30	21	39	7.944	39	36	33	45	8.374	33	17	22	51
7.549	42	24	22	51	7.955	42	33	30	48	8.381	48	30	22	42
7.552	36	33	27	39	7.964	33	39	48	51	8.388	55	27	21	51
7.557	42	22	19	48	7.972	36	22	19	39	8.392	36	33	30	39
7.563	33	20	22	48	7.977	42	27	20	39	8.400	42	30	27	45
7.566	39	27	22	42	7.983	45	21	19	51	8.403	45	21	20	51
7.571	33	19	17	39	7.988	55	27	20	51	8.412	39	30	33	51
7.576	60	33	20	48	7.993	33	17	21	51	8.422	45	22	21	51
7.583	39	30	21	36	8.000	36	33	..	45	8.426	39	27	21	36
7.589	55	27	19	51	8.011	39	21	22	51	8.438	36	24	27	48
7.597	39	33	27	42	8.016	33	19	18	39	8.444	48	24	19	45
7.600	36	20	19	45	8.021	42	24	22	48	8.452	39	19	21	51
7.605	42	27	22	45	8.028	51	24	17	45	8.462	33	36	..	39
7.612	33	17	20	51	8.036	45	36	27	42	8.471	36	17	18	45
7.615	33	30	27	39	8.042	48	27	19	42	8.482	45	24	19	42
7.619	48	30	20	42	8.050	39	19	20	51	8.488	55	27	20	48
7.623	39	27	19	36	8.059	30	21	22	39	8.493	33	17	21	48
7.628	42	24	17	39	8.063	55	27	19	48	8.497	39	27	30	51
7.636	36	22	21	45	8.067	36	21	24	51	8.502	30	19	21	39
7.639	33	27	30	48	8.072	39	18	19	51	8.512	39	24	22	42
7.646	51	27	17	42	8.077	45	30	21	39	8.515	48	21	19	51
7.656	42	24	21	48	8.081	60	33	20	45	8.523	45	22	20	48
7.669	48	27	22	51	8.088	33	24	30	51	8.531	39	20	21	48
7.677	36	27	19	33	8.095	17	45	..	21	8.538	55	24	19	51
7.684	33	17	19	48	8.105	33	19	21	45	8.545	51	27	19	42
7.692	30	36	..	39	8.114	21	55	51	24	8.553	39	19	20	48
7.697	39	19	18	48	8.120	55	33	19	39	8.556	42	30	22	36
7.700	33	20	21	45	8.128	48	22	19	51	8.571	36	33	..	42
7.704	39	27	24	45	8.143	36	20	19	42	8.576	39	24	19	36
7.714	36	30	27	42	8.148	22	42	..	27	8.594	33	24	30	48
7.721	45	24	21	51	8.157	51	33	19	36	8.603	39	24	27	51
7.727	17	45	..	22	8.163	30	21	24	42	8.615	42	30	24	39
7.734	33	24	27	48	8.167	42	24	21	45	8.627	42	21	22	51
7.738	39	36	30	42	8.173	45	24	17	39	8.636	19	45	..	22
7.741	55	30	19	45	8.182	27	39	..	33	8.643	33	20	22	42
7.749	48	27	17	39	8.196	33	17	19	45	8.654	45	36	27	39
7.758	48	33	24	45	8.205	48	36	24	39	8.661	48	27	19	39
7.765	36	30	33	51	8.211	39	19	18	45	8.667	39	33	..	45
7.778	21	42	..	27	8.231	33	21	22	42	8.673	45	21	17	42
7.792	51	30	22	48	8.235	48	24	21	51	8.684	33	19	24	48
7.800	39	30	27	45	8.242	51	33	24	45	8.693	51	22	18	48
7.813	45	24	20	48	8.250	33	20	24	48	8.708	33	20	19	36
7.822	48	30	22	45	8.254	39	27	24	42	8.715	60	27	20	51
7.829	42	19	17	48	8.259	36	19	17	39	8.720	36	17	21	51
7.832	42	33	24	39	8.264	51	27	21	48	8.727	36	30	24	33
7.841	39	21	19	45	8.273	39	30	21	33	8.730	33	27	30	42
7.846	51	30	18	39	8.282	51	30	19	39	8.739	39	21	24	51
7.857	33	36	..	42	8.289	36	19	21	48	8.745	27	19	24	39
7.861	42	22	21	51	8.296	42	27	24	45	8.750	21	45	..	24
7.870	45	27	17	36	8.305	36	17	20	51	8.754	39	27	20	33
7.875	42	30	27	48	8.308	36	30	27	39	8.758	51	22	17	45
7.879	39	33	30	45	8.312	48	33	24	42	8.766	45	33	27	42



CINCINNATI DIAL TYPE MILLING MACHINES

TABLE OF LEADS (8.769 to 10.094)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
8.769	36	20	19	39	9.184	30	21	27	42	9.630	39	27	24	36
8.775	42	27	22	39	9.192	39	27	21	33	9.636	42	19	17	39
8.782	33	17	19	42	9.202	51	27	19	39	9.643	36	24	27	42
8.787	55	27	22	51	9.205	36	22	27	48	9.651	48	21	19	45
8.791	30	21	24	39	9.211	42	19	20	48	9.659	39	19	24	51
8.796	60	27	19	48	9.215	55	27	19	42	9.670	33	21	24	39
8.800	33	20	24	45	9.231	36	33	39	36	9.676	55	24	19	45
8.811	42	33	27	39	9.236	42	24	19	36	9.686	39	17	19	45
8.815	51	27	21	45	9.244	45	21	22	51	9.692	42	30	27	39
8.821	39	20	19	42	9.253	45	22	19	42	9.700	55	27	20	42
8.827	39	27	22	36	9.259	60	27	20	48	9.706	36	24	33	51
8.831	48	22	17	42	9.273	51	33	27	45	9.714	51	21	18	45
8.839	33	24	27	42	9.281	33	20	27	48	9.722	45	27	21	36
8.844	39	21	20	42	9.288	45	19	20	51	9.728	39	21	22	42
8.854	55	22	17	48	9.297	51	24	21	48	9.740	45	33	30	42
8.864	39	33	36	48	9.301	42	22	19	39	9.744	48	24	19	39
8.867	42	20	19	45	9.308	33	20	22	39	9.750	39	30	27	36
8.882	45	19	18	48	9.314	60	24	19	51	9.757	55	21	19	51
8.889	24	42	27	27	9.333	42	30	24	36	9.770	33	19	27	48
8.897	33	17	22	48	9.341	45	21	17	39	9.778	55	30	24	45
8.905	51	30	22	42	9.346	39	27	33	51	9.788	51	30	19	33
8.909	42	22	21	45	9.351	48	33	27	42	9.796	36	21	24	42
8.916	36	19	24	51	9.356	39	24	19	33	9.800	42	20	21	45
8.922	39	18	21	51	9.375	36	24	30	48	9.808	51	24	18	39
8.929	45	24	20	42	9.385	39	22	27	51	9.818	36	20	18	33
8.932	55	30	19	39	9.402	33	27	30	39	9.825	42	19	20	45
8.938	39	20	22	48	9.408	39	19	22	48	9.832	39	21	27	51
8.941	36	17	19	45	9.412	42	21	24	51	9.844	42	24	27	48
8.947	17	45	19	19	9.421	36	22	19	33	9.852	42	18	19	45
8.951	48	33	24	39	9.429	33	21	27	45	9.860	48	21	22	51
8.956	42	27	19	33	9.436	55	24	21	51	9.868	45	19	20	48
8.964	48	21	20	51	9.441	45	33	27	39	9.872	55	30	21	39
8.972	51	24	19	45	9.446	39	17	21	51	9.877	48	27	20	36
8.980	39	19	21	48	9.455	39	30	24	33	9.882	36	17	21	45
8.990	33	39	51	48	9.474	18	45	19	19	9.886	55	24	22	51
9.000	27	42	30	30	9.481	48	27	24	45	9.890	30	21	27	39
9.015	42	22	17	36	9.490	33	17	22	45	9.894	51	27	22	42
9.023	30	19	24	42	9.500	19	45	20	20	9.900	33	20	27	45
9.031	51	20	17	48	9.506	55	27	21	45	9.907	48	19	20	51
9.048	19	45	21	21	9.510	51	33	24	39	9.917	30	22	24	33
9.053	55	27	20	45	9.519	33	24	27	39	9.926	45	24	27	51
9.059	42	30	33	51	9.524	20	45	21	21	9.931	39	24	22	36
9.066	27	42	55	39	9.533	39	20	22	45	9.935	51	33	27	42
9.071	55	24	19	48	9.536	42	19	22	51	9.955	33	17	20	39
9.076	36	21	27	51	9.545	21	45	22	22	9.959	55	27	22	45
9.081	39	17	19	48	9.549	55	24	20	48	9.965	36	17	24	51
9.091	30	36	33	33	9.559	39	24	30	51	9.969	51	27	19	36
9.098	33	19	22	42	9.563	51	20	18	48	9.972	39	22	27	48
9.102	42	19	21	51	9.573	42	27	24	39	9.989	55	24	17	39
9.107	51	36	27	42	9.579	39	19	21	45	10.000	24	45	24	24
9.117	48	27	20	39	9.586	45	19	17	42	10.026	55	24	21	48
9.123	39	19	20	45	9.590	51	30	22	39	10.031	36	19	27	51
9.135	45	24	19	39	9.596	45	27	19	33	10.037	39	17	21	48
9.141	39	24	27	48	9.600	48	30	27	45	10.053	60	27	19	42
9.148	39	18	19	45	9.603	55	30	22	42	10.065	42	27	33	51
9.150	42	27	30	51	9.608	42	18	21	51	10.070	36	22	24	39
9.154	51	30	21	39	9.613	51	24	19	42	10.076	42	22	19	36
9.167	33	39	36	36	9.619	55	27	17	36	10.084	45	21	24	51
9.176	39	30	36	51	9.625	42	20	22	48	10.094	51	20	19	48

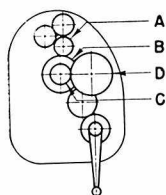
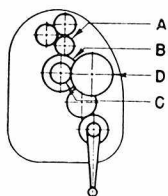


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (10.096 to 11.692)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
10.096	45	24	21	39	10.625	51	24	18	36	11.156	51	20	21	48
10.102	33	21	27	42	10.636	39	22	27	45	11.165	55	24	19	39
10.107	42	22	27	51	10.644	60	21	19	51	11.172	39	24	33	48
10.119	55	22	17	42	10.655	51	27	22	39	11.176	19	45	..	17
10.125	36	20	27	48	10.658	36	19	27	48	11.184	45	19	17	36
10.133	48	20	19	45	10.670	55	27	22	42	11.189	48	33	30	39
10.142	51	22	21	48	10.688	33	19	24	39	11.200	42	30	36	45
10.150	30	19	27	42	10.694	42	27	33	48	11.204	55	24	22	45
10.156	39	24	30	48	10.699	51	22	18	39	11.211	36	17	27	51
10.160	60	22	19	51	10.706	42	30	39	51	11.216	39	17	22	45
10.168	33	17	22	42	10.714	33	22	30	42	11.224	45	21	22	42
10.173	42	17	21	51	10.739	42	22	27	48	11.230	42	22	30	51
10.185	55	27	24	48	10.744	39	22	20	33	11.250	27	42	..	24
10.200	51	30	27	45	10.751	55	27	19	36	11.259	48	18	19	45
10.208	42	24	21	36	10.756	48	21	24	51	11.278	45	19	20	42
10.217	45	19	22	51	10.769	42	33	..	39	11.282	55	30	24	39
10.227	36	22	30	48	10.774	48	27	20	33	11.294	51	22	19	39
10.236	48	27	19	33	10.784	45	27	33	51	11.298	55	21	22	51
10.252	55	19	17	48	10.794	51	27	24	42	11.308	42	20	21	39
10.263	39	19	24	48	10.800	36	20	27	45	11.313	42	27	24	33
10.271	55	21	20	51	10.809	42	17	21	48	11.317	55	27	20	36
10.280	42	22	21	39	10.818	51	22	21	45	11.324	42	24	33	51
10.286	48	30	27	42	10.822	55	18	17	48	11.329	36	22	27	39
10.294	55	22	21	51	10.827	36	19	24	42	11.336	42	19	20	39
10.303	51	33	24	36	10.833	39	33	..	36	11.345	45	21	27	51
10.313	45	30	33	48	10.855	45	19	22	48	11.352	55	19	20	51
10.324	45	19	17	39	10.860	30	17	24	39	11.364	45	33	30	36
10.340	48	21	19	42	10.867	39	19	27	51	11.368	36	19	27	45
10.353	51	24	19	39	10.875	51	27	19	33	11.375	42	30	39	48
10.362	45	19	21	48	10.884	48	21	20	42	11.383	55	18	19	51
10.370	42	27	24	36	10.889	42	18	21	45	11.396	60	27	20	39
10.378	39	17	19	42	10.900	45	17	21	51	11.407	42	27	33	45
10.385	45	30	27	39	10.909	36	39	..	33	11.416	55	21	17	39
10.390	48	22	20	42	10.913	55	24	20	42	11.423	33	20	27	39
10.400	39	30	36	45	10.919	33	17	27	48	11.429	24	45	..	21
10.408	51	21	18	42	10.924	39	21	30	51	11.435	39	18	19	36
10.413	36	22	21	33	10.931	30	19	27	39	11.442	51	24	21	39
10.421	33	19	27	45	10.940	48	27	24	39	11.455	42	22	27	45
10.431	42	17	19	45	10.950	33	17	22	39	11.471	39	17	24	48
10.440	45	21	19	39	10.962	45	20	19	39	11.483	36	19	20	33
10.446	55	27	20	39	10.969	55	27	21	39	11.491	55	27	22	39
10.452	33	17	21	39	10.980	42	18	24	51	11.503	48	18	22	51
10.462	48	20	17	39	10.986	51	21	19	42	11.515	60	22	19	45
10.476	22	45	..	21	10.992	42	22	19	33	11.529	42	17	21	45
10.490	45	33	30	39	11.000	33	42	..	30	11.538	45	30	..	39
10.500	21	45	..	20	11.014	45	22	21	39	11.546	39	19	27	48
10.505	39	27	24	33	11.020	36	21	27	42	11.556	39	27	36	45
10.515	39	24	33	51	11.029	45	24	30	51	11.570	42	22	20	33
10.519	36	22	27	42	11.039	51	33	30	42	11.579	22	45	..	19
10.526	20	45	..	19	11.053	21	45	..	19	11.591	51	22	21	42
10.547	45	24	27	48	11.058	55	21	19	45	11.607	39	24	30	42
10.556	19	45	..	18	11.073	48	17	20	51	11.611	55	20	19	45
10.577	33	24	30	39	11.080	39	22	30	48	11.624	51	27	24	39
10.582	60	27	20	42	11.092	36	21	33	51	11.636	48	22	24	45
10.588	18	45	..	17	11.111	30	39	..	27	11.647	33	17	27	45
10.593	39	27	33	45	11.123	39	33	48	51	11.660	36	19	24	39
10.601	55	21	17	42	11.131	51	24	22	42	11.667	42	33	..	36
10.607	33	20	27	42	11.136	42	22	21	36	11.688	60	33	27	42
10.614	33	19	22	36	11.146	36	19	30	51	11.692	48	20	19	39



CINCINNATI DIAL TYPE MILLING MACHINES

TABLE OF LEADS (11.703 to 13.303)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
11.703	42	19	27	51	12.217	45	17	18	39	12.745	45	27	39	51
11.719	45	24	30	48	12.222	33	39	..	27	12.750	51	30	27	36
11.729	39	19	24	42	12.235	51	22	19	36	12.759	55	21	19	39
11.733	48	20	22	45	12.245	45	21	24	42	12.768	39	24	33	42
11.743	51	19	21	48	12.250	42	20	21	36	12.773	48	17	19	42
11.748	42	22	24	39	12.273	27	42	..	22	12.784	45	22	30	48
11.752	55	24	20	39	12.281	42	19	20	36	12.795	60	27	19	33
11.765	20	48	..	17	12.303	51	19	22	48	12.800	48	20	24	45
11.769	51	30	27	39	12.308	42	21	24	39	12.806	55	17	19	48
11.777	45	22	19	33	12.316	39	19	27	45	12.817	51	21	19	36
11.789	42	19	24	45	12.325	55	21	24	51	12.821	55	22	20	39
11.806	55	22	17	36	12.338	60	22	19	42	12.829	39	19	30	48
11.813	42	20	27	48	12.346	60	27	20	36	12.834	48	22	30	51
11.818	39	36	..	33	12.353	21	45	..	17	12.857	27	45	..	21
11.831	51	21	19	39	12.364	51	22	24	45	12.866	55	19	20	45
11.842	45	19	24	48	12.375	33	24	27	30	12.879	51	33	30	36
11.846	42	30	33	39	12.381	39	27	36	42	12.891	45	24	33	48
11.852	48	27	24	36	12.389	51	19	18	39	12.896	45	17	19	39
11.863	33	17	22	36	12.397	45	22	20	33	12.904	39	17	27	48
11.868	36	21	27	39	12.409	39	22	21	30	12.919	30	19	27	33
11.875	51	17	19	48	12.418	60	18	19	51	12.923	42	20	24	39
11.883	55	27	21	36	12.423	51	20	19	39	12.929	48	27	24	33
11.889	48	19	24	51	12.434	42	19	27	48	12.941	22	45	..	17
11.895	42	27	39	51	12.440	55	20	19	42	12.952	51	21	24	45
11.900	51	20	21	45	12.449	55	27	22	36	12.963	55	27	21	33
11.905	45	27	30	42	12.457	45	17	24	51	12.981	45	24	27	39
11.912	36	17	27	48	12.462	36	20	27	39	12.991	48	18	19	39
11.917	39	30	33	36	12.467	51	20	22	45	13.000	39	36	..	30
11.922	48	17	19	45	12.472	55	21	20	42	13.017	45	22	21	33
11.932	42	22	30	48	12.479	33	17	27	42	13.026	36	19	33	48
11.939	39	21	27	42	12.487	55	19	22	51	13.032	36	17	24	39
11.946	33	17	24	39	12.500	45	33	..	36	13.040	51	22	27	48
11.953	51	24	27	48	12.513	39	22	36	51	13.061	48	21	24	42
11.963	51	18	19	45	12.526	51	19	21	45	13.072	60	18	20	51
11.973	48	21	22	42	12.536	55	27	24	39	13.080	42	17	27	51
11.983	55	18	20	51	12.544	39	19	22	36	13.095	45	27	33	42
11.987	51	24	22	39	12.549	48	18	24	51	13.109	39	21	36	51
12.000	36	39	..	30	12.557	39	33	51	48	13.117	36	19	27	39
12.004	55	21	22	48	12.564	42	18	21	39	13.125	42	24	36	48
12.017	39	21	33	51	12.571	36	21	33	45	13.131	39	27	30	33
12.024	33	19	27	39	12.582	55	18	21	51	13.149	45	22	27	42
12.031	42	24	33	48	12.587	45	33	36	39	13.162	42	27	33	39
12.037	39	27	30	36	12.593	51	27	24	36	13.176	42	17	24	45
12.042	51	20	17	36	12.600	42	20	27	45	13.181	55	18	22	51
12.053	55	17	19	51	12.606	39	33	48	45	13.187	36	21	30	39
12.057	36	19	21	33	12.618	55	19	17	39	13.195	39	19	27	42
12.063	60	21	19	45	12.632	24	45	..	19	13.200	36	20	33	45
12.074	39	19	30	51	12.639	42	27	39	48	13.209	39	17	19	33
12.088	33	21	30	39	12.656	45	20	27	48	13.217	42	22	27	39
12.095	55	24	19	36	12.662	39	22	30	42	13.223	48	22	20	33
12.101	48	21	27	51	12.667	60	20	19	45	13.233	48	19	22	42
12.108	39	17	19	36	12.675	51	19	17	36	13.241	39	27	33	36
12.115	42	24	27	39	12.687	55	17	20	51	13.247	51	22	24	42
12.121	60	22	20	45	12.692	45	30	33	39	13.263	42	19	27	45
12.133	42	30	39	45	12.698	48	27	30	42	13.268	55	19	22	48
12.149	42	22	21	33	12.706	36	17	27	45	13.281	51	24	30	48
12.179	60	24	19	39	12.721	51	21	22	42	13.287	48	17	24	51
12.188	39	22	33	48	12.727	42	36	..	33	13.295	39	22	36	48
12.201	45	19	17	33	12.731	55	24	20	36	13.303	42	17	21	39

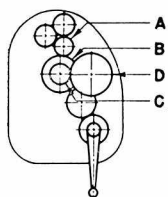
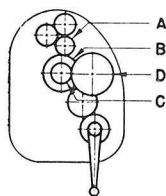


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (13.322 to 15.231)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
13.322	45	19	27	48	13.929	39	22	33	42	14.592	39	21	33	42
13.333	48	33	36	36	13.937	42	17	22	39	14.599	42	22	39	51
13.347	51	22	19	33	13.956	55	17	22	51	14.609	51	24	33	48
13.357	51	20	22	42	13.971	60	17	19	48	14.615	60	20	19	39
13.368	55	24	21	36	13.986	60	33	30	39	14.625	39	30	27	24
13.375	48	19	27	51	14.000	42	36	30	30	14.636	55	17	19	42
13.382	42	24	39	51	14.005	55	24	22	36	14.641	51	19	18	33
13.388	36	22	27	33	14.014	45	17	27	51	14.652	60	21	20	39
13.397	55	20	19	39	14.020	39	18	33	51	14.661	36	17	27	39
13.406	39	20	33	48	14.026	48	22	27	42	14.667	55	20	24	45
13.421	51	19	24	48	14.035	60	19	20	45	14.682	51	20	19	33
13.431	55	21	20	39	14.060	51	19	22	42	14.694	48	21	27	42
13.439	33	17	27	39	14.066	48	21	24	39	14.706	45	18	30	51
13.445	48	21	30	51	14.074	60	18	19	45	14.712	51	24	27	39
13.458	51	20	19	36	14.103	60	24	22	39	14.727	36	22	27	30
13.468	60	27	20	33	14.112	39	19	33	48	14.737	42	19	30	45
13.474	48	19	24	45	14.118	24	48	17	17	14.748	39	17	27	42
13.481	42	27	39	45	14.141	42	27	30	33	14.752	51	22	21	33
13.492	51	27	30	42	14.152	55	19	22	45	14.769	48	20	24	39
13.500	27	42	20	20	14.161	45	22	27	39	14.774	55	21	22	39
13.509	42	19	22	36	14.167	51	24	30	45	14.790	48	21	33	51
13.523	51	24	21	33	14.182	39	30	36	33	14.803	45	19	30	48
13.534	36	19	30	42	14.211	27	42	19	19	14.808	42	24	33	39
13.542	45	27	39	48	14.219	42	24	39	48	14.815	55	27	24	33
13.571	60	20	19	42	14.225	42	17	19	33	14.824	42	17	27	45
13.580	55	27	24	36	14.251	48	19	22	39	14.835	45	21	27	39
13.600	51	20	24	45	14.259	42	27	33	36	14.841	51	27	33	42
13.611	42	18	21	36	14.266	51	22	24	39	14.850	33	20	27	30
13.622	55	19	24	51	14.286	30	39	21	21	14.861	48	19	30	51
13.636	45	36	33	33	14.300	39	20	33	45	14.875	51	20	21	36
13.660	55	17	19	45	14.316	51	19	24	45	14.886	55	18	19	39
13.670	55	19	17	36	14.338	45	24	39	51	14.890	45	17	27	48
13.675	48	27	30	39	14.344	51	20	27	48	14.896	39	36	33	24
13.684	39	19	30	45	14.351	39	33	51	42	14.903	51	22	27	42
13.700	51	21	22	39	14.359	42	27	36	39	14.928	39	19	24	33
13.714	48	21	27	45	14.379	55	18	24	51	14.938	55	27	22	30
13.719	55	21	22	42	14.385	51	30	33	39	14.945	51	21	24	39
13.725	45	27	42	51	14.394	60	24	19	33	14.954	51	18	19	36
13.731	51	20	21	39	14.400	48	20	27	45	14.966	55	21	24	42
13.737	51	27	24	33	14.405	55	20	22	42	14.973	42	17	20	33
13.750	33	42	24	24	14.412	42	17	21	36	15.000	45	36	30	30
13.756	48	17	19	39	14.423	45	24	30	39	15.038	60	19	20	42
13.765	39	17	27	45	14.429	55	18	17	36	15.043	48	27	33	39
13.776	45	21	27	42	14.436	48	19	24	42	15.053	39	19	33	45
13.788	42	36	39	33	14.444	39	36	27	27	15.059	48	17	24	45
13.804	48	17	22	45	14.453	51	19	21	39	15.072	45	19	21	33
13.816	42	19	30	48	14.464	45	20	27	42	15.079	60	21	19	36
13.823	55	21	19	36	14.474	55	19	24	48	15.098	55	17	21	45
13.841	60	17	20	51	14.480	48	17	20	39	15.105	48	22	27	39
13.846	48	24	27	39	14.489	51	22	30	48	15.111	51	30	24	27
13.853	48	21	20	33	14.504	39	22	27	33	15.126	45	21	36	51
13.866	45	21	33	51	14.514	55	20	19	36	15.152	45	33	30	27
13.878	51	21	24	42	14.530	51	27	30	39	15.158	48	19	27	45
13.884	42	22	24	33	14.538	42	20	27	39	15.167	42	36	39	30
13.889	45	27	30	36	14.545	48	36	33	33	15.179	51	24	30	42
13.897	42	17	27	48	14.550	55	27	30	42	15.195	39	22	36	42
13.904	39	17	20	33	14.559	36	17	33	48	15.204	42	17	24	39
13.909	51	30	27	33	14.571	51	21	27	45	15.225	55	17	24	51
13.919	60	21	19	39	14.583	42	36	30	24	15.231	36	20	33	39



CINCINNATI DIAL TYPE MILLING MACHINES

TABLE OF LEADS (15.241 to 17.550)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
15.241	45	17	19	33	15.966	60	17	19	42	16.783	48	22	30	39
15.256	51	18	21	39	15.983	51	27	33	39	16.794	39	19	27	33
15.273	42	33	36	30	16.000	48	36	..	30	16.800	42	20	36	45
15.278	55	24	24	36	16.032	36	19	33	39	16.806	55	30	33	36
15.294	42	21	39	51	16.042	42	36	33	24	16.813	51	21	27	39
15.300	51	20	27	45	16.049	51	22	27	39	16.824	39	17	33	45
15.306	45	21	30	42	16.071	45	24	36	42	16.837	45	21	33	42
15.311	48	19	20	33	16.082	55	19	20	36	16.845	45	22	42	51
15.321	39	20	33	42	16.105	51	19	27	45	16.852	42	36	39	27
15.338	51	19	24	42	16.117	55	21	24	39	16.859	51	22	24	33
15.354	48	18	19	33	16.127	55	18	19	36	16.875	45	24	27	30
15.385	45	39	36	27	16.134	48	21	36	51	16.886	55	19	21	36
15.395	39	19	36	48	16.150	51	20	19	30	16.904	42	19	39	51
15.400	42	20	33	45	16.162	48	33	30	27	16.917	45	19	30	42
15.407	39	27	48	45	16.176	55	17	24	48	16.932	55	20	24	39
15.429	36	21	27	30	16.190	51	21	30	45	16.947	55	17	22	42
15.439	55	19	24	45	16.200	36	20	27	30	16.970	42	33	36	27
15.441	42	17	30	48	16.211	42	19	33	45	16.985	42	17	33	48
15.455	51	36	..	33	16.239	60	18	19	39	17.000	51	36	..	30
15.469	45	20	33	48	16.250	39	36	..	24	17.017	45	17	27	42
15.476	45	27	39	42	16.257	48	17	19	33	17.028	55	19	30	51
15.502	36	19	27	33	16.283	55	19	27	48	17.045	45	33	30	24
15.513	55	20	22	39	16.290	36	17	30	39	17.053	36	19	27	30
15.529	36	17	33	45	16.296	48	27	33	36	17.063	42	20	39	48
15.547	48	19	24	39	16.313	51	18	19	33	17.075	55	17	19	36
15.556	42	36	..	27	16.327	48	21	30	42	17.081	51	19	21	33
15.571	45	17	30	51	16.333	42	18	21	30	17.094	60	27	30	39
15.577	45	20	27	39	16.346	51	24	30	39	17.105	39	19	30	36
15.587	55	19	21	39	16.364	36	39	..	22	17.112	48	17	20	33
15.600	39	20	36	45	16.370	39	27	51	45	17.128	45	17	33	51
15.612	51	21	27	42	16.387	45	21	39	51	17.143	36	39	..	21
15.620	42	22	27	33	16.397	45	19	27	39	17.172	51	33	30	27
15.625	45	36	30	24	16.404	51	19	22	36	17.182	42	22	27	30
15.632	33	19	27	30	16.410	48	27	36	39	17.195	60	17	19	39
15.642	45	22	39	51	16.421	39	19	36	45	17.206	39	17	36	48
15.658	51	19	21	36	16.450	60	21	19	33	17.225	36	19	30	33
15.670	55	27	30	39	16.471	42	17	30	45	17.236	55	27	33	39
15.686	48	18	30	51	16.484	45	21	30	39	17.255	55	17	24	45
15.692	51	20	24	39	16.500	33	36	..	20	17.273	51	17	19	33
15.714	48	24	33	42	16.508	48	27	39	42	17.308	45	24	36	39
15.724	33	39	..	21	16.518	51	19	24	39	17.316	60	21	20	33
15.734	45	22	30	39	16.529	60	22	20	33	17.326	36	17	27	33
15.741	51	27	30	36	16.544	45	17	30	48	17.333	48	36	39	30
15.750	42	24	27	30	16.558	51	22	30	42	17.347	51	21	30	42
15.762	55	17	19	39	16.579	42	19	36	48	17.355	42	33	30	22
15.772	39	17	33	48	16.593	42	27	48	45	17.368	33	39	..	19
15.789	30	42	..	19	16.609	48	17	30	51	17.376	48	17	24	39
15.817	55	17	22	45	16.615	48	20	27	39	17.386	51	24	27	33
15.824	48	21	27	39	16.623	48	21	24	33	17.411	45	24	39	42
15.833	51	17	19	36	16.639	36	17	33	42	17.421	55	17	21	39
15.865	45	24	33	39	16.667	45	36	..	27	17.439	42	17	36	51
15.873	55	21	20	33	16.684	48	22	39	51	17.455	48	33	36	30
15.882	27	42	..	17	16.696	51	24	33	42	17.471	33	17	27	30
15.889	39	30	33	27	16.705	42	22	21	24	17.479	48	21	39	51
15.909	42	33	30	24	16.714	39	20	36	42	17.490	48	19	27	39
15.918	39	21	36	42	16.725	39	19	22	27	17.500	42	39	..	24
15.928	48	17	22	39	16.736	45	22	27	33	17.531	51	20	33	48
15.938	51	20	30	48	16.762	48	21	33	45	17.540	39	27	51	42
15.955	39	22	27	30	16.776	51	19	30	48	17.550	39	20	27	30

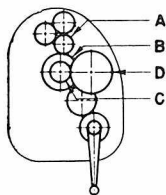
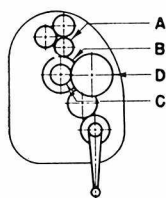


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (17.582 to 20.588)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
17.582	48	21	30	39	18.519	60	27	30	36	19.479	51	24	33	36
17.593	60	18	19	36	18.529	42	17	36	48	19.500	39	36	..	20
17.600	48	20	33	45	18.545	51	30	36	33	19.522	51	19	24	33
17.622	42	39	36	22	18.571	39	36	..	21	19.548	48	17	27	39
17.630	42	27	51	45	18.583	51	19	27	39	19.556	48	30	33	27
17.647	30	39	..	17	18.595	45	22	30	33	19.592	48	21	36	42
17.654	51	20	27	39	18.609	45	19	33	42	19.608	60	17	20	36
17.662	51	21	24	33	18.627	60	17	19	36	19.615	51	24	36	39
17.679	45	20	33	42	18.660	39	19	30	33	19.636	48	22	27	30
17.690	55	19	22	36	18.673	55	27	33	36	19.643	33	21	30	24
17.708	51	24	30	36	18.685	45	17	36	51	19.664	39	17	36	42
17.727	39	36	..	22	18.700	51	20	33	45	19.684	51	19	33	45
17.763	45	19	36	48	18.707	55	21	30	42	19.697	45	33	39	27
17.778	48	33	..	27	18.731	55	19	33	51	19.732	51	24	39	42
17.810	51	21	33	45	18.750	45	36	..	24	19.744	42	18	33	39
17.824	55	18	21	36	18.770	39	17	27	33	19.765	42	17	36	45
17.832	51	22	30	39	18.803	55	18	24	39	19.780	45	21	36	39
17.843	42	18	39	51	18.816	39	19	33	36	19.800	36	30	33	20
17.851	48	22	27	33	18.824	48	18	36	51	19.810	48	21	39	45
17.857	60	24	30	42	18.857	48	20	33	42	19.835	48	22	30	33
17.875	39	30	33	24	18.873	55	17	21	36	19.850	48	19	33	42
17.898	45	22	42	48	18.881	45	22	36	39	19.861	39	27	33	24
17.919	36	17	33	39	18.889	51	33	..	27	19.870	51	22	36	42
17.949	45	39	42	27	18.900	42	20	27	30	19.895	42	19	27	30
17.959	48	21	33	42	18.909	48	33	39	30	19.910	55	17	24	39
17.968	42	17	24	33	18.947	36	39	..	19	19.922	45	24	51	48
17.981	51	24	33	39	18.958	42	36	39	24	19.931	48	17	36	51
18.000	36	39	..	20	18.967	51	22	27	33	20.000	48	36	..	24
18.006	55	24	33	42	18.994	45	22	39	42	20.040	45	19	33	39
18.025	39	17	33	42	19.031	55	17	30	51	20.074	42	17	39	48
18.030	51	18	21	33	19.038	45	20	33	39	20.096	42	19	30	33
18.045	48	19	30	42	19.048	55	21	24	33	20.132	51	19	36	48
18.056	45	36	39	27	19.059	36	17	27	30	20.147	55	21	30	39
18.086	42	19	27	33	19.082	51	21	33	42	20.167	55	20	22	30
18.092	55	19	30	48	19.091	42	36	..	22	20.192	45	39	42	24
18.100	60	17	20	39	19.097	55	24	30	36	20.202	60	27	30	33
18.111	45	19	39	51	19.118	45	18	39	51	20.211	48	19	24	30
18.118	42	17	33	45	19.125	51	24	27	30	20.222	42	30	39	27
18.132	45	21	33	39	19.139	60	19	20	33	20.238	51	21	30	36
18.151	48	17	27	42	19.145	48	39	42	27	20.250	45	20	27	30
18.182	48	33	30	24	19.158	42	19	39	45	20.260	39	33	36	21
18.200	42	20	39	45	19.173	51	19	30	42	20.301	45	19	36	42
18.219	45	19	30	39	19.192	60	18	19	33	20.321	60	17	19	33
18.250	55	17	22	39	19.206	55	21	33	45	20.342	42	27	51	39
18.270	48	17	33	51	19.231	55	22	30	39	20.362	45	17	30	39
18.286	48	21	36	45	19.243	45	19	39	48	20.370	55	33	..	27
18.308	42	30	51	39	19.250	42	30	33	24	20.392	48	18	39	51
18.326	45	17	27	39	19.259	48	36	39	27	20.400	51	20	24	30
18.333	55	33	..	30	19.286	45	21	27	30	20.408	60	21	30	42
18.353	39	17	36	45	19.298	55	19	30	45	20.433	55	19	36	51
18.367	45	21	36	42	19.319	48	19	39	51	20.455	45	36	..	22
18.373	48	19	24	33	19.341	48	21	33	39	20.463	51	36	39	27
18.384	42	33	39	27	19.378	45	19	27	33	20.513	45	27	48	39
18.409	45	22	27	30	19.385	42	20	36	39	20.526	39	36	..	19
18.421	55	19	21	33	19.394	48	33	36	27	20.535	48	17	24	33
18.454	51	19	33	48	19.412	33	36	..	17	20.549	51	21	33	39
18.462	48	24	36	39	19.429	51	21	36	45	20.571	48	21	27	30
18.474	39	19	27	30	19.433	48	19	30	39	20.578	55	21	33	42
18.487	55	17	24	42	19.444	45	36	42	27	20.588	55	17	21	33



CINCINNATI DIAL TYPE MILLING MACHINES

TABLE OF LEADS (20.606 to 24.740)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
20.606	51	33	36	27	21.857	51	21	27	30	23.214	45	36	39	21
20.625	45	30	33	24	21.862	45	19	36	39	23.253	48	17	42	51
20.635	39	21	30	27	21.875	45	36	42	24	23.269	55	20	33	39
20.648	51	19	30	39	21.895	48	19	39	45	23.294	36	17	33	30
20.670	48	19	27	33	21.962	51	19	27	33	23.320	48	19	36	39
20.682	42	33	39	24	21.978	60	21	30	39	23.333	42	36	...	18
20.706	48	17	33	45	22.000	48	30	33	24	23.375	51	30	33	24
20.719	51	20	39	48	22.028	45	39	42	22	23.400	39	30	36	20
20.741	48	36	42	27	22.037	42	27	51	36	23.437	45	24	30	24
20.769	45	20	36	39	22.059	45	17	30	36	23.459	48	19	39	42
20.778	51	30	33	27	22.068	39	36	55	27	23.487	51	19	42	48
20.798	45	17	33	42	22.078	51	21	30	33	23.504	55	18	30	39
20.805	48	19	42	51	22.105	42	36	...	19	23.529	55	17	24	33
20.816	51	21	36	42	22.154	48	20	36	39	23.538	51	20	36	39
20.826	42	33	36	22	22.185	48	17	33	42	23.579	48	19	42	45
20.833	45	27	30	24	22.222	48	36	45	27	23.611	51	27	30	24
20.842	36	30	33	19	22.235	42	17	27	30	23.636	48	33	39	24
20.856	39	17	30	33	22.243	55	17	33	48	23.684	45	33	...	19
20.864	51	22	27	30	22.262	51	21	33	36	23.725	55	17	22	30
20.905	42	17	33	39	22.286	39	30	36	21	23.765	42	27	55	36
20.934	55	17	33	51	22.313	51	20	42	48	23.800	51	20	42	45
20.952	48	21	33	36	22.323	51	33	39	27	23.810	45	21	30	27
20.979	60	22	30	39	22.344	39	24	33	24	23.824	45	17	27	30
21.000	42	39	...	20	22.368	51	19	30	36	23.833	39	27	33	20
21.010	48	33	39	27	22.392	39	33	36	19	23.864	45	33	42	24
21.029	39	17	33	36	22.400	48	20	42	45	23.891	48	17	33	39
21.053	55	19	24	33	22.418	51	21	36	39	23.947	42	19	39	36
21.074	51	22	30	33	22.449	55	21	36	42	23.974	51	18	33	39
21.099	48	21	36	39	22.460	42	17	30	33	24.000	48	33	...	20
21.154	55	20	30	39	22.500	45	36	...	20	24.040	51	33	42	27
21.176	36	39	...	17	22.551	51	21	39	42	24.063	42	24	33	24
21.212	45	33	42	27	22.564	48	18	33	39	24.074	55	27	39	33
21.228	55	19	22	30	22.579	39	30	33	19	24.115	42	33	36	19
21.250	51	33	...	24	22.588	48	17	36	45	24.123	55	19	30	36
21.273	39	30	36	22	22.626	42	27	48	33	24.158	51	19	27	30
21.316	45	19	27	30	22.667	51	30	36	27	24.176	55	21	36	39
21.333	48	30	36	27	22.689	45	17	36	42	24.202	48	17	36	42
21.377	48	19	33	39	22.698	39	27	33	21	24.231	45	20	42	39
21.389	42	27	33	24	22.713	51	19	33	39	24.242	48	33	45	27
21.399	51	22	36	39	22.727	45	27	30	22	24.265	55	17	36	48
21.412	42	17	39	45	22.737	48	19	27	30	24.286	51	33	...	21
21.429	45	36	...	21	22.744	55	19	33	42	24.292	60	19	30	39
21.450	39	30	33	20	22.750	42	30	39	24	24.316	42	30	33	19
21.474	51	19	36	45	22.768	51	21	45	48	24.375	45	30	39	24
21.507	45	17	39	48	22.805	42	17	36	39	24.402	51	19	30	33
21.526	51	22	39	42	22.837	55	17	36	51	24.434	45	17	36	39
21.538	48	24	42	39	22.857	48	33	...	21	24.444	55	30	36	27
21.577	51	20	33	39	22.885	51	24	42	39	24.471	48	17	39	45
21.592	48	17	39	51	22.909	42	30	36	22	24.494	55	19	33	39
21.607	55	20	33	42	22.917	55	30	...	24	24.519	45	24	51	39
21.636	51	33	42	30	22.941	39	36	...	17	24.545	45	30	36	22
21.654	48	19	36	42	22.967	48	19	30	33	24.561	42	19	30	27
21.667	39	36	...	18	23.008	51	19	36	42	24.580	45	17	39	42
21.711	55	19	36	48	23.021	51	24	39	36	24.605	51	19	33	36
21.719	48	17	30	39	23.077	48	24	45	39	24.615	48	21	42	39
21.795	51	18	30	39	23.100	42	30	33	20	24.632	39	30	36	19
21.809	51	19	39	48	23.111	48	30	39	27	24.706	42	36	...	17
21.818	48	33	...	22	23.158	55	19	24	30	24.727	48	22	51	45
21.825	55	21	30	36	23.182	51	33	...	22	24.740	55	17	39	51

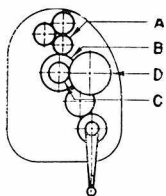
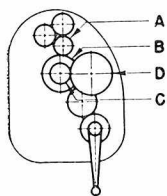


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (24.750 to 30.390)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
24.750	45	30	33	20	26.353	48	17	42	45	28.373	55	21	39	36
24.762	39	27	36	21	26.374	48	21	45	39	28.421	45	30	36	19
24.777	51	19	36	39	26.400	48	30	33	20	28.437	42	24	39	24
24.793	60	22	30	33	26.442	45	24	55	39	28.507	45	17	42	39
24.826	55	24	39	36	26.471	45	36	...	17	28.519	55	27	42	30
24.887	55	17	30	39	26.494	51	33	36	21	28.547	55	17	45	51
24.914	48	17	45	51	26.526	42	30	36	19	28.571	48	21	30	24
24.925	51	19	39	42	26.535	55	19	33	36	28.636	45	30	42	22
24.935	48	33	36	21	26.591	45	30	39	22	28.676	45	36	39	17
24.965	51	22	42	39	26.644	55	17	42	51	28.701	51	33	39	21
25.000	51	17	30	36	26.667	48	36	...	18	28.718	48	18	42	39
25.027	39	33	36	17	26.714	51	30	33	21	28.737	42	30	39	19
25.053	51	19	42	45	26.748	51	22	45	39	28.759	51	19	45	42
25.088	39	27	33	19	26.765	42	36	39	17	28.810	55	30	33	21
25.114	51	33	39	24	26.786	45	21	30	24	28.875	42	24	33	20
25.143	48	30	33	21	26.812	39	24	33	20	28.889	48	27	39	24
25.175	48	22	45	39	26.842	51	33	...	19	28.907	51	19	42	39
25.200	42	30	36	20	26.880	55	19	39	42	28.947	45	27	33	19
25.210	60	17	30	42	26.952	42	33	36	17	28.977	51	24	45	33
25.235	39	17	33	30	26.984	51	21	30	27	29.079	51	19	39	36
25.263	48	33	...	19	27.000	45	30	36	20	29.091	48	33	42	21
25.278	42	27	39	24	27.018	42	27	33	19	29.101	55	21	30	27
25.289	51	33	36	22	27.045	51	33	42	24	29.118	45	17	33	30
25.325	45	33	39	21	27.068	48	19	45	42	29.143	51	30	36	21
25.385	60	20	33	39	27.083	55	24	39	33	29.167	45	27	42	24
25.397	48	21	30	27	27.149	60	17	30	39	29.198	42	33	39	17
25.412	48	17	27	30	27.176	42	17	33	30	29.221	45	21	30	22
25.420	55	17	33	42	27.206	48	19	42	39	29.250	45	30	39	20
25.455	48	33	42	24	27.273	48	33	45	24	29.282	51	33	36	19
25.463	55	27	30	24	27.300	42	30	39	20	29.333	48	27	33	20
25.490	39	17	30	27	27.368	39	27	36	19	29.412	60	17	30	36
25.500	51	33	...	20	27.397	51	33	39	22	29.423	51	20	45	39
25.536	39	24	33	21	27.429	48	30	36	21	29.474	42	27	36	19
25.568	45	24	30	22	27.462	51	20	42	39	29.504	51	22	42	33
25.641	60	18	30	39	27.500	55	33	...	20	29.526	51	30	33	19
25.658	45	36	39	19	27.529	39	30	36	17	29.545	45	27	39	22
25.668	48	17	30	33	27.560	48	33	36	19	29.605	45	19	30	24
25.714	45	30	36	21	27.576	42	27	39	22	29.630	48	18	30	27
25.758	51	27	30	22	27.632	45	19	42	36	29.657	55	17	33	36
25.785	48	33	39	22	27.692	48	20	45	39	29.683	51	27	33	21
25.837	45	33	36	19	27.731	55	17	36	42	29.714	48	30	39	21
25.846	48	20	42	39	27.755	51	21	48	42	29.750	51	30	42	24
25.855	55	18	33	39	27.769	48	33	42	22	29.774	36	21	33	19
25.882	55	17	36	45	27.789	48	30	33	19	29.792	55	30	39	24
25.905	51	21	48	45	27.818	51	30	36	22	29.825	51	19	30	27
25.926	42	18	30	27	27.857	45	30	39	21	29.864	55	17	36	39
25.972	51	27	33	24	27.937	48	27	33	21	29.890	51	21	48	39
26.000	48	30	39	24	27.990	45	33	39	19	30.000	55	30	36	22
26.020	51	21	45	42	28.009	55	27	33	24	30.042	55	17	39	42
26.033	45	33	42	22	28.022	51	21	45	39	30.136	51	30	39	22
26.053	45	30	33	19	28.039	55	17	39	45	30.144	45	33	42	19
26.063	48	17	36	39	28.050	51	30	33	20	30.196	42	17	33	27
26.124	42	33	39	19	28.070	48	19	30	27	30.222	51	30	48	27
26.154	51	21	42	39	28.125	45	24	36	24	30.252	48	17	45	42
26.182	48	30	36	22	28.224	39	24	33	19	30.303	60	22	30	27
26.218	48	17	39	42	28.235	48	36	...	17	30.316	48	30	36	19
26.250	45	30	42	24	28.283	60	27	42	33	30.333	42	27	39	20
26.287	55	17	39	48	28.309	55	17	42	48	30.357	51	21	30	24
26.310	51	21	39	36	28.333	51	27	33	22	30.390	39	22	36	21



CINCINNATI DIAL TYPE MILLING MACHINES

TABLE OF LEADS (30.407 to 37.227)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
30.407	48	17	42	39	32.566	45	24	33	19	34.895	51	30	39	19
30.450	55	17	48	51	32.579	48	17	45	39	34.921	55	27	36	21
30.476	48	27	36	21	32.692	51	18	45	39	35.000	48	24	42	24
30.513	51	18	42	39	32.727	51	33	36	17	35.049	55	17	39	36
30.545	48	30	42	22	32.738	55	21	30	24	35.065	45	22	36	21
30.556	55	24	36	27	32.807	51	27	33	19	35.079	51	27	39	21
30.588	39	17	36	27	32.842	48	30	39	19	35.088	60	19	30	27
30.600	51	30	36	20	32.906	55	18	42	39	35.188	39	21	36	19
30.643	39	20	33	21	32.941	42	27	36	17	35.256	55	18	45	39
30.677	51	19	48	42	33.000	48	24	33	20	35.294	45	27	36	17
30.694	51	27	39	24	33.016	48	27	39	21	35.325	51	21	48	33
30.769	48	18	45	39	33.036	51	19	48	39	35.357	45	21	33	20
30.789	45	30	39	19	33.056	51	27	42	24	35.368	48	30	42	19
30.802	48	33	36	17	33.088	45	17	30	24	35.380	55	27	33	19
30.882	45	36	42	17	33.117	51	21	30	22	35.417	51	27	45	24
30.909	51	27	36	22	33.158	45	30	42	19	35.455	42	22	39	21
30.937	45	24	33	20	33.239	45	24	39	22	35.526	45	24	36	19
30.952	45	27	39	21	33.277	36	17	33	21	35.556	48	27	42	21
30.972	51	19	45	39	33.333	55	27	36	22	35.588	55	17	33	30
31.023	42	24	39	22	33.369	48	33	39	17	35.648	55	27	42	24
31.059	48	17	33	30	33.393	51	24	33	21	35.686	42	27	39	17
31.111	48	27	42	24	33.429	39	21	36	20	35.700	51	30	42	20
31.167	51	27	33	20	33.485	51	27	39	22	35.714	60	21	30	24
31.200	48	30	39	20	33.553	51	19	30	24	35.750	55	20	39	30
31.250	60	24	30	24	33.589	39	22	36	19	35.795	45	24	42	22
31.283	45	33	39	17	33.611	55	27	33	20	35.921	42	24	39	19
31.316	51	19	42	36	33.684	48	27	36	19	35.936	48	17	42	33
31.360	55	19	39	36	33.704	42	27	39	18	35.948	55	17	30	27
31.385	51	20	48	39	33.719	51	22	48	33	35.962	51	20	55	39
31.429	55	30	36	21	33.750	45	24	36	20	36.000	51	30	36	17
31.481	51	18	30	27	33.772	55	19	42	36	36.012	55	24	33	21
31.500	45	30	42	20	33.846	48	20	55	39	36.050	39	17	33	21
31.515	48	27	39	22	33.868	39	19	33	20	36.061	51	27	42	22
31.544	39	17	33	24	33.882	48	30	36	17	36.096	45	17	30	22
31.571	51	30	39	21	33.939	48	27	42	22	36.111	55	27	39	22
31.612	51	22	45	33	33.951	55	18	30	27	36.172	42	22	36	19
31.722	51	33	39	19	33.971	42	17	33	24	36.184	55	19	45	36
31.746	60	21	30	27	34.000	51	30	48	24	36.364	48	27	45	22
31.765	45	30	36	17	34.048	55	30	39	21	36.397	45	17	33	24
31.818	45	27	42	22	34.091	55	22	45	33	36.429	51	30	45	21
31.842	55	30	33	19	34.125	42	24	39	20	36.474	42	19	33	20
31.875	51	30	45	24	34.163	51	19	42	33	36.491	48	27	39	19
31.909	39	22	36	20	34.211	45	27	39	19	36.562	45	24	39	20
31.930	42	27	39	19	34.249	51	21	55	39	36.603	51	19	45	33
32.000	48	21	42	30	34.286	48	24	36	21	36.667	55	27	36	20
32.011	55	27	33	21	34.375	55	30	45	24	36.706	48	30	39	17
32.083	42	18	33	24	34.412	45	30	39	17	36.818	45	22	36	20
32.118	42	30	39	17	34.450	48	19	30	22	36.842	55	19	42	33
32.143	45	24	36	21	34.510	48	17	33	27	36.908	51	24	33	19
32.164	55	19	30	27	34.531	51	24	39	24	36.923	51	17	48	39
32.211	51	30	36	19	34.615	51	17	45	39	36.947	39	20	36	19
32.231	60	22	39	33	34.630	51	18	33	27	36.975	55	17	48	42
32.256	39	19	33	21	34.667	48	27	39	20	37.037	60	18	30	27
32.297	45	19	30	22	34.711	60	22	42	33	37.059	45	30	42	17
32.308	51	17	42	39	34.737	48	19	33	24	37.091	51	22	48	30
32.353	45	17	33	27	34.773	51	30	45	22	37.143	48	24	39	21
32.381	51	27	36	21	34.821	45	24	39	21	37.187	51	24	42	24
32.455	51	30	42	22	34.842	55	17	42	39	37.218	45	21	33	19
32.500	48	24	39	24	34.872	51	18	48	39	37.227	42	22	39	20

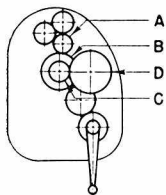
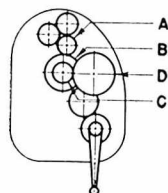


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (37.240 to 46.324)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
37.240	55	24	39	24	40.000	51	27	36	17	43.105	42	20	39	19
37.321	60	19	39	33	40.071	51	21	33	20	43.137	55	27	36	17
37.346	55	18	33	27	40.104	55	24	42	24	43.175	51	27	48	21
37.403	48	22	36	21	40.147	42	24	39	17	43.214	55	21	33	20
37.500	55	24	36	22	40.191	60	19	42	33	43.308	48	21	36	19
37.540	39	17	36	22	40.263	51	24	36	19	43.333	51	27	39	17
37.579	51	30	42	19	40.428	42	22	36	17	43.421	55	19	36	24
37.632	55	19	39	30	40.441	55	17	45	36	43.466	51	24	45	22
37.647	48	27	36	17	40.476	51	27	45	21	43.618	51	24	39	19
37.670	51	24	39	22	40.519	48	22	39	21	43.636	48	22	42	21
37.714	48	21	33	20	40.568	51	24	42	22	43.651	55	21	45	27
37.745	55	17	42	36	40.602	45	21	36	19	43.676	45	17	33	20
37.778	51	27	48	24	40.625	60	24	39	24	43.714	51	21	36	20
37.812	55	24	33	20	40.741	55	27	42	21	43.750	60	24	42	24
37.831	55	27	39	21	40.765	42	17	33	20	43.797	42	22	39	17
37.853	39	17	33	20	40.784	48	27	39	17	43.923	51	22	36	19
37.895	48	30	45	19	40.800	51	20	48	30	43.985	45	21	39	19
37.917	42	24	39	18	40.909	60	20	30	22	44.000	48	18	33	20
37.987	45	22	39	21	40.926	51	27	39	18	44.074	51	27	42	18
38.182	48	24	42	22	41.053	48	24	39	19	44.118	60	17	30	24
38.194	55	27	45	24	41.143	48	21	36	20	44.136	55	18	39	27
38.235	45	27	39	17	41.176	45	27	42	17	44.211	48	24	42	19
38.250	51	24	36	20	41.212	51	27	48	22	44.289	51	20	33	19
38.487	45	24	39	19	41.250	55	24	36	20	44.318	60	24	39	22
38.500	55	20	42	30	41.270	60	21	39	27	44.370	48	17	33	21
38.519	48	27	39	18	41.294	39	17	36	20	44.444	48	27	45	18
38.571	45	21	36	20	41.340	48	22	36	19	44.471	42	20	36	17
38.596	55	27	36	19	41.364	42	22	39	18	44.485	55	17	33	24
38.636	51	27	45	22	41.437	51	24	39	20	44.524	51	18	33	21
38.756	45	22	36	19	41.481	48	27	42	18	44.571	48	21	39	20
38.772	51	27	39	19	41.597	45	17	33	21	44.625	51	24	42	20
38.824	48	17	33	24	41.667	55	27	45	22	44.687	55	24	39	20
38.857	51	30	48	21	41.684	48	19	33	20	44.737	51	27	45	19
38.889	60	24	42	27	41.711	60	17	39	33	44.785	48	22	39	19
38.958	51	18	33	24	41.727	51	22	36	20	44.920	60	17	42	33
39.000	51	30	39	17	41.754	51	27	42	19	45.000	55	22	36	20
39.043	51	19	48	33	41.786	45	21	39	20	45.029	55	19	42	27
39.079	45	20	33	19	41.813	55	27	39	19	45.205	51	22	39	20
39.187	42	22	39	19	41.905	48	18	33	21	45.215	45	22	42	19
39.216	60	17	30	27	41.986	45	22	39	19	45.294	55	17	42	30
39.273	48	22	36	20	42.000	48	24	42	20	45.333	51	27	48	20
39.286	55	22	33	21	42.014	55	18	33	24	45.378	45	21	36	17
39.298	48	27	42	19	42.059	55	17	39	30	45.455	60	22	45	27
39.328	39	17	36	21	42.105	48	27	45	19	45.474	48	20	36	19
39.375	45	24	42	20	42.180	51	21	33	19	45.489	55	21	33	19
39.394	60	22	39	27	42.308	55	17	51	39	45.500	42	20	39	18
39.464	51	24	39	21	42.353	48	30	45	17	45.536	51	24	45	21
39.474	55	19	45	33	42.424	60	22	42	27	45.614	60	19	39	27
39.529	48	30	42	17	42.500	51	27	45	20	45.714	48	21	36	18
39.542	55	17	33	27	42.545	48	22	39	20	45.818	48	22	42	20
39.667	51	27	42	20	42.560	55	24	39	21	45.833	55	24	48	24
39.699	48	21	33	19	42.632	45	20	36	19	45.882	48	24	39	17
39.722	55	27	39	20	42.778	55	27	42	20	45.975	45	17	33	19
39.740	51	22	36	21	42.910	42	17	33	19	46.015	51	21	36	19
39.789	42	20	36	19	42.947	51	19	48	30	46.042	51	24	39	18
39.803	55	24	33	19	42.969	55	24	45	24	46.184	45	20	39	19
39.819	55	17	48	39	43.015	45	24	39	17	46.203	48	22	36	17
39.845	39	17	33	19	43.052	51	22	39	21	46.316	48	18	33	19
39.886	45	22	39	20	43.062	60	19	30	22	46.324	45	24	42	17



CINCINNATI DIAL TYPE MILLING MACHINES

TABLE OF LEADS (46.364 to 60.662)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
46.364	51	24	48	22	50.155	45	19	36	17	54.643	51	21	45	20
46.429	60	24	39	21	50.227	51	22	39	18	54.678	55	19	51	27
46.561	55	21	48	27	50.329	51	24	45	19	54.737	48	19	39	18
46.588	48	17	33	20	50.370	51	27	48	18	54.902	60	17	42	27
46.667	51	27	42	17	50.417	55	18	33	20	55.000	55	24	48	20
46.732	55	27	39	17	50.526	48	21	42	19	55.059	48	20	39	17
46.753	48	21	45	22	50.649	60	22	39	21	55.250	51	20	39	18
46.811	42	17	36	19	50.712	42	19	39	17	55.263	55	22	42	19
46.875	60	24	45	24	50.794	60	21	48	27	55.462	55	21	36	17
46.925	45	22	39	17	50.824	48	20	36	17	55.556	60	18	45	27
46.974	51	24	42	19	50.840	55	17	33	21	55.588	45	20	42	17
47.039	55	24	39	19	50.909	48	22	42	18	55.636	51	22	48	20
47.059	48	27	45	17	50.926	55	18	45	27	55.655	55	24	51	21
47.143	55	21	36	20	50.980	60	17	39	27	55.714	60	21	39	20
47.222	51	27	45	18	51.000	51	24	48	20	55.981	60	22	39	19
47.273	48	22	39	18	51.071	55	21	39	20	56.000	48	20	42	18
47.357	51	21	39	20	51.136	60	22	45	24	56.140	60	19	48	27
47.531	55	18	42	27	51.244	51	19	42	22	56.192	55	17	33	19
47.584	51	22	39	19	51.316	55	22	39	19	56.250	55	22	45	20
47.619	60	21	45	27	51.429	48	21	45	20	56.368	51	20	42	19
47.647	45	20	36	17	51.462	55	19	48	27	56.447	55	20	39	19
47.719	51	27	48	19	51.562	55	24	45	20	56.471	48	21	42	17
47.763	55	20	33	19	51.618	45	20	39	17	56.618	55	24	42	17
47.812	51	24	45	20	51.675	48	22	45	19	56.667	51	24	48	18
47.895	42	19	39	18	51.852	60	18	42	27	56.746	55	21	39	18
48.000	48	21	42	20	51.944	55	20	51	27	56.842	51	19	36	17
48.016	55	18	33	21	52.000	48	20	39	18	57.143	55	22	48	21
48.125	55	24	42	20	52.105	55	20	36	19	57.273	60	22	42	20
48.148	60	18	39	27	52.159	51	22	45	20	57.292	55	24	45	18
48.176	42	20	39	17	52.342	51	20	39	19	57.353	55	22	39	17
48.230	48	22	42	19	52.381	55	24	48	21	57.519	51	21	45	19
48.246	55	19	45	27	52.437	48	21	39	17	57.716	55	18	51	27
48.316	51	20	36	19	52.500	55	22	42	20	57.754	48	22	45	17
48.403	48	21	36	17	52.574	55	24	39	17	57.895	55	24	48	19
48.485	60	22	48	27	52.632	60	19	45	27	57.957	48	19	39	17
48.529	55	24	36	17	52.941	48	24	45	17	58.158	51	19	39	18
48.571	51	24	48	21	52.987	51	22	48	21	58.235	55	20	36	17
48.698	55	24	51	24	53.053	48	20	42	19	58.286	51	21	48	20
48.750	55	22	39	20	53.070	55	18	33	19	58.333	55	22	42	18
48.889	55	20	48	27	53.125	55	24	51	22	58.437	55	24	51	20
49.040	48	17	33	19	53.182	60	22	39	20	58.500	51	20	39	17
49.091	51	22	36	17	53.333	51	27	48	17	58.514	45	19	42	17
49.107	55	24	45	21	53.382	55	17	33	20	58.565	51	22	48	19
49.123	60	19	42	27	53.472	55	24	42	18	58.647	60	21	39	19
49.160	45	21	39	17	53.498	48	19	36	17	58.824	60	17	45	27
49.211	55	19	51	30	53.529	42	18	39	17	58.929	55	21	45	20
49.263	48	20	39	19	53.571	55	22	45	21	58.947	48	19	42	18
49.412	60	17	42	30	53.684	51	24	48	19	59.091	60	22	39	18
49.471	55	21	51	27	53.759	55	21	39	19	59.211	55	22	45	19
49.500	51	17	33	20	53.904	48	22	42	17	59.259	60	18	48	27
49.524	48	21	39	18	53.922	55	17	45	27	59.294	48	20	42	17
49.583	51	24	42	18	54.000	51	20	36	17	59.500	51	20	42	18
49.624	55	21	36	19	54.091	51	22	42	18	59.583	55	20	39	18
49.653	55	24	39	18	54.135	48	21	45	19	60.000	60	21	42	20
49.675	51	22	45	21	54.167	55	22	39	18	60.084	55	21	39	17
49.737	45	20	42	19	54.276	55	19	45	24	60.287	60	19	42	22
49.850	51	21	39	19	54.321	55	18	48	27	60.395	51	20	45	19
50.000	55	24	48	22	54.334	45	19	39	17	60.504	48	21	45	17
50.053	48	22	39	17	54.545	60	22	48	24	60.662	55	17	45	24

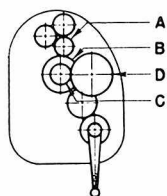


TABLE OF LEADS, ENCLOSED DRIVING MECHANISM

TABLE OF LEADS (60.714 to 107.843)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
60.714	55	22	51	21	66.873	48	19	45	17	76.471	60	18	39	17
60.789	55	20	42	19	67.105	55	22	51	19	76.625	55	19	45	17
61.111	55	21	42	18	67.380	60	17	42	22	76.692	60	19	51	21
61.176	48	18	39	17	67.500	51	20	45	17	77.005	60	17	48	22
61.300	55	19	36	17	67.554	55	19	42	18	77.193	55	19	48	18
61.364	51	22	45	17	67.669	60	19	45	21	77.273	60	18	51	22
61.513	55	19	51	24	67.941	55	20	42	17	77.647	55	20	48	17
61.579	60	20	39	19	68.000	51	20	48	18	77.917	55	20	51	18
61.765	55	22	42	17	68.182	60	18	45	22	78.019	60	19	42	17
61.818	51	22	48	18	68.421	60	19	39	18	78.571	55	21	51	17
61.905	60	21	39	18	68.571	60	20	48	21	78.947	60	18	45	19
62.030	55	21	45	19	68.750	55	20	45	18	79.412	60	17	45	20
62.338	60	21	48	22	68.824	60	20	39	17	80.000	51	18	48	17
62.415	48	19	42	17	68.900	60	19	48	22	80.526	60	19	51	20
62.500	55	22	45	18	69.328	55	21	45	17	80.672	60	17	48	21
62.567	60	22	39	17	69.474	55	20	48	19	80.882	55	18	45	17
62.632	51	19	42	18	69.545	60	20	51	22	80.952	60	18	51	21
62.719	55	19	39	18	69.841	55	21	48	18	81.734	55	19	48	17
62.745	60	17	48	27	70.000	60	20	42	18	81.818	60	17	51	22
62.857	55	21	48	20	70.098	55	18	39	17	82.018	55	19	51	18
62.963	60	18	51	27	70.301	55	21	51	19	82.353	60	18	42	17
63.000	51	20	42	17	70.588	55	22	48	17	82.500	55	20	51	17
63.088	55	20	39	17	70.833	55	22	51	18	82.707	60	19	55	21
63.158	55	22	48	19	71.053	60	19	45	20	83.333	60	18	55	22
63.529	48	20	45	17	71.429	60	18	45	21	83.591	60	19	45	17
63.636	60	18	42	22	71.517	55	19	42	17	84.211	60	18	48	19
63.750	55	22	51	20	71.579	51	19	48	18	84.706	60	17	48	20
64.167	55	18	42	20	72.000	51	20	48	17	85.000	60	18	51	20
64.286	60	21	45	20	72.180	60	19	48	21	85.714	60	17	51	21
64.421	51	20	48	19	72.368	55	19	45	18	86.275	55	18	48	17
64.593	60	19	45	22	72.446	60	19	39	17	86.842	55	19	51	17
64.706	55	21	42	17	72.727	60	18	48	22	87.302	60	18	55	21
64.762	51	21	48	18	72.794	55	20	45	17	88.235	60	18	45	17
64.931	55	18	51	24	72.857	60	20	51	21	89.164	60	17	48	19
65.000	60	20	39	18	73.206	60	19	51	22	89.474	60	18	51	19
65.132	55	20	45	19	73.333	55	20	48	18	90.000	60	17	51	20
65.455	60	20	48	22	73.684	60	19	42	18	91.667	60	18	55	20
65.476	55	21	45	18	73.816	55	20	51	19	92.437	60	17	55	21
65.546	60	21	39	17	73.950	55	21	48	17	94.118	60	18	48	17
65.882	48	18	42	17	74.118	60	20	42	17	94.737	60	17	51	19
66.165	55	21	48	19	74.206	55	21	51	18	96.491	60	18	55	19
66.234	60	21	51	22	75.000	55	22	51	17	97.059	60	17	55	20
66.316	60	20	42	19	75.490	55	18	42	17	100.000	60	17	51	18
66.409	55	19	39	17	75.630	60	17	45	21	102.167	60	17	55	19
66.667	60	21	42	18	75.789	51	19	48	17	107.843	60	17	55	18
66.786	55	21	51	20	76.190	60	18	48	21					

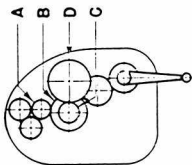
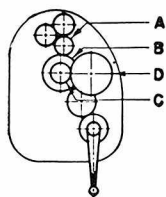


TABLE OF CHANGE GEARS, APPROXIMATE ANGLES, AND ENGLISH LEADS
APPROXIMATE ANGLES FOR CUTTING SPIRALS

TABLE OF CHANGE GEARS, APPROXIMATE ANGLES, AND ENGLISH LEADS
FOR CUTTING SPIRALS—(Concluded)

Lead of Spiral Inches	A		B		C		D		DIAMETER OF WORK																								
	Driven	Driver	Driven	Driver	Driven	Driver	Driven	Driver	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/2	5	5 1/2	6	
15.24	45	17	33	33	33	33	33	33	1 1/2	3	4 1/2	5 3/4	7 1/4	8 3/4	10 1/4	11 3/4	14 1/2	17 1/4	20	22 1/2	25	27 1/4	29 1/2	31 3/4	34	35 3/4	37 3/4	39 1/2	42 3/4	46	48 1/2	51	
15.56	42	36	27	27	27	27	27	27	1 1/4	2 3/4	4 1/4	5 1/2	7	8 1/2	9 3/4	10 1/2	12 1/4	14 1/4	17	19 1/2	22	24 1/2	27	29 1/2	31 1/4	33 1/4	35 1/4	37	39	42 1/4	45 1/4	48	50 1/2
15.75	42	24	27	30	30	30	30	30	1 1/4	2 3/4	4 1/4	5 1/2	7	8 1/2	9 3/4	10 1/2	12 1/4	14 1/4	17	19 1/2	22	24 1/2	27	29 1/2	31 1/4	33 1/4	35 1/4	37	39	42 1/4	45 1/4	48	50 1/2
16.87	45	24	27	30	30	30	30	30	1 1/4	2 3/4	4 1/4	5 1/2	7	8 1/2	9 3/4	10 1/2	12 1/4	14 1/4	17	19 1/2	22	24 1/2	27	29 1/2	31 1/4	33 1/4	35 1/4	37	39	42 1/4	45 1/4	48	50 1/2
17.14	36	39	30	30	30	30	30	30	1 1/4	2 3/4	4 1/4	5 1/2	7	8 1/2	9 3/4	10 1/2	12 1/4	14 1/4	17	19 1/2	22	24 1/2	27	29 1/2	31 1/4	33 1/4	35 1/4	37	39	42 1/4	45 1/4	48	50 1/2
18.75	45	36	24	24	24	24	24	24	1	2 1/4	3 1/2	4 1/2	5 3/4	7 1/4	8 3/4	9 3/4	11 1/2	13 3/4	16	18 1/4	20 1/4	22 1/4	24 3/4	26 3/4	28 3/4	30 3/4	32 3/4	34 3/4	36 3/4	39 3/4	42 3/4	45 3/4	47 3/4
19.29	45	21	27	30	30	30	30	30	1	2 1/4	3 1/2	4 1/2	5 3/4	7 1/4	8 3/4	9 3/4	11 1/2	13 3/4	16	18 1/4	20 1/4	22 1/4	24 3/4	26 3/4	28 3/4	30 3/4	32 3/4	34 3/4	36 3/4	39 3/4	42 3/4	45 3/4	47 3/4
19.59	48	21	36	42	42	42	42	42	1	2 1/4	3 1/2	4 1/2	5 3/4	7 1/4	8 3/4	9 3/4	11 1/2	13 3/4	16	18 1/4	20 1/4	22 1/4	24 3/4	26 3/4	28 3/4	30 3/4	32 3/4	34 3/4	36 3/4	39 3/4	42 3/4	45 3/4	47 3/4
19.69	51	19	33	45	19	33	45	19	1	2 1/4	3 1/2	4 1/2	5 3/4	7 1/4	8 3/4	9 3/4	11 1/2	13 3/4	16	18 1/4	20 1/4	22 1/4	24 3/4	26 3/4	28 3/4	30 3/4	32 3/4	34 3/4	36 3/4	39 3/4	42 3/4	45 3/4	47 3/4
21.43	45	36	21	21	21	21	21	21	1	2	3 1/4	4 1/4	5 1/4	6 1/4	7 1/2	8 1/2	10 1/2	12 1/2	14 1/2	16 1/2	18 1/2	20 1/4	22 1/4	24 3/4	26 3/4	28 3/4	30 3/4	32 3/4	34 3/4	36 3/4	39 3/4	42 3/4	45 3/4
22.50	45	36	21	21	21	21	21	21	1	2	3 1/4	4 1/4	5 1/4	6 1/4	7 1/2	8 1/2	10 1/2	12 1/2	14 1/2	16 1/2	18 1/2	20 1/4	22 1/4	24 3/4	26 3/4	28 3/4	30 3/4	32 3/4	34 3/4	36 3/4	39 3/4	42 3/4	45 3/4
23.33	42	36	21	21	21	21	21	21	1	2	3 1/4	4 1/4	5 1/4	6 1/4	7 1/2	8 1/2	10 1/2	12 1/2	14 1/2	16 1/2	18 1/2	20 1/4	22 1/4	24 3/4	26 3/4	28 3/4	30 3/4	32 3/4	34 3/4	36 3/4	39 3/4	42 3/4	45 3/4
26.25	45	30	42	30	42	30	42	30	1	1 3/4	2 3/4	3 1/2	4 1/4	5	6	7 3/4	9 3/4	11 1/2	13 1/2	15 1/2	17 1/2	19 1/4	21 1/4	23 1/4	25 1/4	27 1/4	29 1/4	31 1/4	33 1/4	35 1/4	37 1/4	40	43 1/4
26.67	48	36	24	24	24	24	24	24	1	1 3/4	2 3/4	3 1/2	4 1/4	5	6	7 3/4	9 3/4	11 1/2	13 1/2	15 1/2	17 1/2	19 1/4	21 1/4	23 1/4	25 1/4	27 1/4	29 1/4	31 1/4	33 1/4	35 1/4	37 1/4	40	43 1/4
28.00	48	30	42	24	42	24	42	24	1	1 3/4	2 3/4	3 1/2	4 1/4	5	6	7 3/4	9 3/4	11 1/2	13 1/2	15 1/2	17 1/2	19 1/4	21 1/4	23 1/4	25 1/4	27 1/4	29 1/4	31 1/4	33 1/4	35 1/4	37 1/4	40	43 1/4
30.88	45	36	42	36	42	36	42	36	1	1 3/4	2 3/4	3 1/2	4 1/4	5	6	7 3/4	9 3/4	11 1/2	13 1/2	15 1/2	17 1/2	19 1/4	21 1/4	23 1/4	25 1/4	27 1/4	29 1/4	31 1/4	33 1/4	35 1/4	37 1/4	40	43 1/4
31.50	45	30	42	36	42	36	42	36	1	1 3/4	2 3/4	3 1/2	4 1/4	5	6	7 3/4	9 3/4	11 1/2	13 1/2	15 1/2	17 1/2	19 1/4	21 1/4	23 1/4	25 1/4	27 1/4	29 1/4	31 1/4	33 1/4	35 1/4	37 1/4	40	43 1/4
36.00	51	30	36	17	36	17	36	17	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
41.14	48	21	36	20	36	20	36	20	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
45.00	55	22	36	20	36	20	36	20	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
48.00	48	21	42	20	42	20	42	20	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
51.43	48	21	42	20	42	20	42	20	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
60.00	60	21	42	20	42	20	42	20	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
63.00	51	20	42	17	42	17	42	17	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
65.00	60	20	42	18	42	18	42	18	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
70.00	60	20	42	18	42	18	42	18	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
72.00	51	20	48	17	48	17	48	17	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
75.00	55	22	51	17	51	17	51	17	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
80.00	51	18	48	17	48	17	48	17	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
85.00	60	18	51	20	51	20	51	20	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
90.00	60	17	51	20	51	20	51	20	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
100.00	60	17	51	18	51	18	51	18	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2
107.80	60	17	55	18	55	18	55	18	1 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	6 1/4	7 1/4	8 3/4	10 1/4	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2	23 1/2



CINCINNATI DIAL TYPE MILLING MACHINES

ENGLISH LEADS AND CHANGE GEARS FOR MILLING SPIRAL END MILLS

Set Machine Table to Angle of Approximately 20 Degrees

Diameter of Mill, Inches	Lead in Inches	Driven A	Driver B	Driven C	Driver D
$\frac{3}{8}$	3.24	27	33	19	48
$\frac{1}{2}$	4.32	36	33	19	48
$\frac{5}{8}$	5.40	45	33	19	48
$\frac{3}{4}$	6.48	42	27	20	48
$\frac{7}{8}$	7.56	42	22	19	48
1	8.64	42	27	20	36
$1\frac{1}{8}$	9.72	45	27	21	36
$1\frac{1}{4}$	10.79	36	20	27	45
$1\frac{3}{8}$	11.87	36	21	27	39
$1\frac{1}{2}$	12.94	22	45	..	17
$1\frac{3}{4}$	15.11	48	22	27	39
2	17.26	51	19	27	42
$2\frac{1}{4}$	19.41	33	36	..	17
$2\frac{1}{2}$	21.58	51	20	33	39
$2\frac{3}{4}$	23.73	55	17	22	30
3	25.88	55	17	36	45
$3\frac{1}{4}$	28.05	51	30	33	20
$3\frac{1}{2}$	30.22	51	30	48	27
$3\frac{3}{4}$	32.38	51	27	36	21
4	34.53	51	24	39	24

ENGLISH LEADS AND CHANGE GEARS FOR MILLING SPIRAL MILLING CUTTERS

Set Machine Table to Angle of Approximately 25 Degrees

Diameter of Mill, Inches	Lead in Inches	Driven A	Driver B	Driven C	Driver D
$\frac{1}{2}$	3.37	27	33	21	51
$\frac{5}{8}$	4.22	27	24	18	48
$\frac{3}{4}$	5.05	30	33	20	36
$\frac{7}{8}$	5.89	33	36	27	42
1	6.74	39	27	21	45
$1\frac{1}{4}$	8.42	48	19	17	51
$1\frac{1}{2}$	10.11	42	22	27	51
$1\frac{3}{4}$	11.79	42	19	42	45
2	13.47	36	21	33	42
$2\frac{1}{4}$	15.16	48	19	27	45
$2\frac{1}{2}$	16.84	48	19	30	45
$2\frac{3}{4}$	18.53	42	17	36	48
3	20.20	60	27	30	33
$3\frac{1}{4}$	21.90	48	19	39	45
$3\frac{1}{2}$	23.58	48	19	42	45
$3\frac{3}{4}$	25.26	48	33	..	19
4	26.95	42	33	36	17
$4\frac{1}{4}$	28.63	51	19	48	45
$4\frac{1}{2}$	30.32	48	30	36	19
$4\frac{3}{4}$	32.00	48	21	42	30
5	33.69	45	33	42	17
$5\frac{1}{4}$	35.37	48	30	42	19
$5\frac{1}{2}$	37.06	45	30	42	17
$5\frac{3}{4}$	38.76	45	22	36	19
6	40.43	42	22	36	17

TABLE OF TANGENTS

TABLE OF TANGENTS

(Natural Tangents at Intervals of $\frac{1}{4}^\circ$)

Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent
0°	.0000	13°	.2309	26°	.4877	39°	.8098	52°	1.280	65°	2.145	78°	4.705
$\frac{1}{4}$	.0044	$13\frac{1}{4}$	.2355	$26\frac{1}{4}$	.4931	$39\frac{1}{4}$	.8170	$52\frac{1}{4}$	1.292	$65\frac{1}{4}$	2.169	$78\frac{1}{4}$	4.808
$\frac{1}{2}$	.0087	$13\frac{1}{2}$	.2401	$26\frac{1}{2}$	.4986	$39\frac{1}{2}$	.8243	$52\frac{1}{2}$	1.303	$65\frac{1}{2}$	2.194	$78\frac{1}{2}$	4.915
$\frac{3}{4}$	.0131	$13\frac{3}{4}$	.2447	$26\frac{3}{4}$	.5040	$39\frac{3}{4}$	.8317	$52\frac{3}{4}$	1.315	$65\frac{3}{4}$	2.220	$78\frac{3}{4}$	5.027
1°	.0175	14°	.2493	27°	.5095	40°	.8391	53°	1.327	66°	2.246	79°	5.145
$1\frac{1}{4}$	.0218	$14\frac{1}{4}$	.2540	$27\frac{1}{4}$	.5150	$40\frac{1}{4}$	.8466	$53\frac{1}{4}$	1.339	$66\frac{1}{4}$	2.273	$79\frac{1}{4}$	5.267
$1\frac{1}{2}$	.0262	$14\frac{1}{2}$	.2586	$27\frac{1}{2}$	.5206	$40\frac{1}{2}$	.8541	$53\frac{1}{2}$	1.351	$66\frac{1}{2}$	2.300	$79\frac{1}{2}$	5.396
$1\frac{3}{4}$	.0306	$14\frac{3}{4}$	.2633	$27\frac{3}{4}$	.5261	$40\frac{3}{4}$	.8617	$53\frac{3}{4}$	1.364	$66\frac{3}{4}$	2.328	$79\frac{3}{4}$	5.530
2°	.0349	15°	.2680	28°	.5317	41°	.8693	54°	1.376	67°	2.356	80°	5.671
$2\frac{1}{4}$	.0393	$15\frac{1}{4}$	.2726	$28\frac{1}{4}$	.5373	$41\frac{1}{4}$	.8770	$54\frac{1}{4}$	1.389	$67\frac{1}{4}$	2.385	$80\frac{1}{4}$	5.820
$2\frac{1}{2}$	.0437	$15\frac{1}{2}$	.2773	$28\frac{1}{2}$	.5430	$41\frac{1}{2}$	.8847	$54\frac{1}{2}$	1.402	$67\frac{1}{2}$	2.414	$80\frac{1}{2}$	5.976
$2\frac{3}{4}$	.0480	$15\frac{3}{4}$	.2820	$28\frac{3}{4}$	.5486	$41\frac{3}{4}$	.8925	$54\frac{3}{4}$	1.415	$67\frac{3}{4}$	2.444	$80\frac{3}{4}$	6.140
3°	.0524	16°	.2867	29°	.5543	42°	.9004	55°	1.428	68°	2.475	81°	6.314
$3\frac{1}{4}$	.0568	$16\frac{1}{4}$	.2915	$29\frac{1}{4}$	.5600	$42\frac{1}{4}$	.9083	$55\frac{1}{4}$	1.442	$68\frac{1}{4}$	2.507	$81\frac{1}{4}$	6.497
$3\frac{1}{2}$	.0612	$16\frac{1}{2}$	.2962	$29\frac{1}{2}$	.5658	$42\frac{1}{2}$	.9163	$55\frac{1}{2}$	1.455	$68\frac{1}{2}$	2.539	$81\frac{1}{2}$	6.691
$3\frac{3}{4}$	.0655	$16\frac{3}{4}$	.3010	$29\frac{3}{4}$	.5716	$42\frac{3}{4}$	.9244	$55\frac{3}{4}$	1.469	$68\frac{3}{4}$	2.572	$81\frac{3}{4}$	6.897
4°	.0699	17°	.3057	30°	.5774	43°	.9325	56°	1.483	69°	2.605	82°	7.115
$4\frac{1}{4}$	.0743	$17\frac{1}{4}$	.3105	$30\frac{1}{4}$	.5832	$43\frac{1}{4}$	.9407	$56\frac{1}{4}$	1.497	$69\frac{1}{4}$	2.639	$82\frac{1}{4}$	7.348
$4\frac{1}{2}$	.0787	$17\frac{1}{2}$	.3153	$30\frac{1}{2}$	.5890	$43\frac{1}{2}$	.9490	$56\frac{1}{2}$	1.511	$69\frac{1}{2}$	2.675	$82\frac{1}{2}$	7.596
$4\frac{3}{4}$	.0831	$17\frac{3}{4}$	.3201	$30\frac{3}{4}$	.5949	$43\frac{3}{4}$	.9573	$56\frac{3}{4}$	1.525	$69\frac{3}{4}$	2.711	$82\frac{3}{4}$	7.861
5°	.0875	18°	.3249	31°	.6009	44°	.9657	57°	1.540	70°	2.748	83°	8.144
$5\frac{1}{4}$	.0919	$18\frac{1}{4}$	.3298	$31\frac{1}{4}$	.6068	$44\frac{1}{4}$	.9742	$57\frac{1}{4}$	1.555	$70\frac{1}{4}$	2.785	$83\frac{1}{4}$	8.449
$5\frac{1}{2}$	.0963	$18\frac{1}{2}$	.3346	$31\frac{1}{2}$	.6128	$44\frac{1}{2}$	.9827	$57\frac{1}{2}$	1.570	$70\frac{1}{2}$	2.824	$83\frac{1}{2}$	8.777
$5\frac{3}{4}$	.1007	$18\frac{3}{4}$	.3395	$31\frac{3}{4}$	.6188	$44\frac{3}{4}$	.9913	$57\frac{3}{4}$	1.585	$70\frac{3}{4}$	2.864	$83\frac{3}{4}$	9.131
6°	.1051	19°	.3443	32°	.6249	45°	1.000	58°	1.600	71°	2.904	84°	9.514
$6\frac{1}{4}$	.1095	$19\frac{1}{4}$	.3492	$32\frac{1}{4}$	.6310	$45\frac{1}{4}$	1.009	$58\frac{1}{4}$	1.616	$71\frac{1}{4}$	2.946	$84\frac{1}{4}$	9.931
$6\frac{1}{2}$	.1139	$19\frac{1}{2}$	.3541	$32\frac{1}{2}$	.6371	$45\frac{1}{2}$	1.018	$58\frac{1}{2}$	1.632	$71\frac{1}{2}$	2.989	$84\frac{1}{2}$	10.385
$6\frac{3}{4}$	.1184	$19\frac{3}{4}$	.3590	$32\frac{3}{4}$	.6432	$45\frac{3}{4}$	1.027	$58\frac{3}{4}$	1.648	$71\frac{3}{4}$	3.033	$84\frac{3}{4}$	10.883
7°	.1228	20°	.3640	33°	.6494	46°	1.036	59°	1.664	72°	3.078	85°	11.430
$7\frac{1}{4}$	.1272	$20\frac{1}{4}$	.3689	$33\frac{1}{4}$	.6556	$46\frac{1}{4}$	1.045	$59\frac{1}{4}$	1.681	$72\frac{1}{4}$	3.124	$85\frac{1}{4}$	12.035
$7\frac{1}{2}$	.1317	$20\frac{1}{2}$	.3739	$33\frac{1}{2}$	.6619	$46\frac{1}{2}$	1.054	$59\frac{1}{2}$	1.698	$72\frac{1}{2}$	3.172	$85\frac{1}{2}$	12.706
$7\frac{3}{4}$	.1361	$20\frac{3}{4}$	.3789	$33\frac{3}{4}$	.6682	$46\frac{3}{4}$	1.063	$59\frac{3}{4}$	1.715	$72\frac{3}{4}$	3.221	$85\frac{3}{4}$	13.457
8°	.1405	21°	.3839	34°	.6745	47°	1.072	60°	1.732	73°	3.271	86°	14.301
$8\frac{1}{4}$	.1450	$21\frac{1}{4}$	.3889	$34\frac{1}{4}$	.6809	$47\frac{1}{4}$	1.082	$60\frac{1}{4}$	1.750	$73\frac{1}{4}$	3.323	$86\frac{1}{4}$	15.257
$8\frac{1}{2}$	.1495	$21\frac{1}{2}$	.3939	$34\frac{1}{2}$	.6873	$47\frac{1}{2}$	1.091	$60\frac{1}{2}$	1.768	$73\frac{1}{2}$	3.376	$86\frac{1}{2}$	16.350
$8\frac{3}{4}$	.1539	$21\frac{3}{4}$	.3990	$34\frac{3}{4}$	.6937	$47\frac{3}{4}$	1.101	$60\frac{3}{4}$	1.786	$73\frac{3}{4}$	3.431	$86\frac{3}{4}$	17.610
9°	.1584	22°	.4040	35°	.7002	48°	1.111	61°	1.804	74°	3.487	87°	19.081
$9\frac{1}{4}$	.1629	$22\frac{1}{4}$	.4091	$35\frac{1}{4}$	.7067	$48\frac{1}{4}$	1.120	$61\frac{1}{4}$	1.823	$74\frac{1}{4}$	3.546	$87\frac{1}{4}$	20.819
$9\frac{1}{2}$	.1673	$22\frac{1}{2}$	.4142	$35\frac{1}{2}$	.7133	$48\frac{1}{2}$	1.130	$61\frac{1}{2}$	1.842	$74\frac{1}{2}$	3.606	$87\frac{1}{2}$	22.904
$9\frac{3}{4}$	.1718	$22\frac{3}{4}$	.4193	$35\frac{3}{4}$	.7199	$48\frac{3}{4}$	1.140	$61\frac{3}{4}$	1.861	$74\frac{3}{4}$	3.668	$87\frac{3}{4}$	24.452
10°	.1763	23°	.4245	36°	.7265	49°	1.150	62°	1.881	75°	3.732	88°	28.636
$10\frac{1}{4}$	.1808	$23\frac{1}{4}$	.4296	$36\frac{1}{4}$	.7332	$49\frac{1}{4}$	1.161	$62\frac{1}{4}$	1.901	$75\frac{1}{4}$	3.798	$88\frac{1}{4}$	32.730
$10\frac{1}{2}$	.1853	$23\frac{1}{2}$	.4348	$36\frac{1}{2}$	.7400	$49\frac{1}{2}$	1.171	$62\frac{1}{2}$	1.921	$75\frac{1}{2}$	3.867	$88\frac{1}{2}$	38.188
$10\frac{3}{4}$	.1899	$23\frac{3}{4}$	.4400	$36\frac{3}{4}$	.7467	$49\frac{3}{4}$	1.181	$62\frac{3}{4}$	1.942	$75\frac{3}{4}$	3.938	$88\frac{3}{4}$	45.829
11°	.1944	24°	.4452	37°	.7536	50°	1.192	63°	1.963	76°	4.011	89°	57.29
$11\frac{1}{4}$	.1989	$24\frac{1}{4}$	.4505	$37\frac{1}{4}$	.7604	$50\frac{1}{4}$	1.202	$63\frac{1}{4}$	1.984	$76\frac{1}{4}$	4.087	$89\frac{1}{4}$	76.39
$11\frac{1}{2}$	.2035	$24\frac{1}{2}$	.4557	$37\frac{1}{2}$	.7673	$50\frac{1}{2}$	1.213	$63\frac{1}{2}$	2.006	$76\frac{1}{2}$	4.165	$89\frac{1}{2}$	114.59
$11\frac{3}{4}$	.2080	$24\frac{3}{4}$	.4610	$37\frac{3}{4}$	.7743	$50\frac{3}{4}$	1.224	$63\frac{3}{4}$	2.028	$76\frac{3}{4}$	4.247	$89\frac{3}{4}$	229.18
12°	.2126	25°	.4663	38°	.7813	51°	1.235	64°	2.050	77°	4.332	90°	
$12\frac{1}{4}$	.2171	$25\frac{1}{4}$	.4716	$38\frac{1}{4}$	.7883	$51\frac{1}{4}$	1.246	$64\frac{1}{4}$	2.073	$77\frac{1}{4}$	4.419		
$12\frac{1}{2}$	.2217	$25\frac{1}{2}$	.4770	$38\frac{1}{2}$	.7954	$51\frac{1}{2}$	1.257	$64\frac{1}{2}$	2.097	$77\frac{1}{2}$	4.511		
$12\frac{3}{4}$	.2263	$25\frac{3}{4}$	.4823	$38\frac{3}{4}$	.8026	$51\frac{3}{4}$	1.269	$64\frac{3}{4}$	2.120	$77\frac{3}{4}$	4.606		

ORDERING REPAIR PARTS

You will receive quicker service when ordering repair parts if you will adhere to the following procedure:

1. **State amount wanted.**
2. **Give part number and name or description of part, and where obtained.**
 - (a) Parts catalog.
 - (b) Parts number stamped on part.
 - (c) Prior invoice.
3. **Give complete serial number of machine.** The serial number will be found stamped in two places: Horizontal Machines, on the face of the column near the spindle, and front of the table near the right hand end. Vertical Machines, top of the scraped bearing for the knee and front of the table near the right hand end.
4. **Specify each individual piece required.** If only certain parts of a unit are required, never use the word "complete"; it always raises the question as to how much of the unit to supply. In some cases, due to the nature of the parts, it will be less costly to you for us to supply additional related pieces, especially if part wanted is obsolete.
5. **Specify how and where to ship.** Do not say "Ship quickest way". Be definite and state the agency desired, that is:—Air Mail, Parcel Post, Special Delivery, Express, Motor Freight, Rail Freight, etc.

MEMORANDUM

CINCINNATI DIAL TYPE MILLING MACHINES

MEMORANDUM

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CINCINNATI

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO 45209 U.S.A.

PRODUCTS OF THE CINCINNATI MILLING MACHINE CO. INCLUDE A COMPLETE LINE OF GENERAL PURPOSE MILLING MACHINES, MACHINING CENTERS, PRODUCTION MILLING MACHINES, DIE SINKING AND PROFILE MILLING MACHINES, CUTTER AND TOOL GRINDING MACHINES, CENTERTYPE GRINDING MACHINES, CENTERLESS GRINDING MACHINES, ROLL GRINDING MACHINES, CHUCKING GRINDING MACHINES, MICRO-CENTRIC GRINDING MACHINES, SPECIAL GRINDING MACHINES, ELECTRICAL MACHINING EQUIPMENT, METAL FORMING MACHINES, SPECIAL BROACHING MACHINES, SPECIAL MACHINE TOOLS AND COMPLETE PRODUCTION LINES, SPECIAL MACHINERY, NUMERICAL CONTROL SYSTEMS, TRACING SYSTEMS, GAGING SYSTEMS, HYDRAULIC MOTORS, HYDRAULIC AND ELECTRO-HYDRAULIC VALVES AND COMPONENTS, SERVICE PARTS, CUTTING FLUIDS AND PRECISION GRINDING WHEELS.